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ABSTRACT

This Missouri Vocational Instruction Management System instructor's drafting guide has been keyed to the drafting competency profile developed by state industry and education professionals. The guide contains a cross-reference table of instructional materials. Ten units cover drafting fundamentals: (1) introduction to drafting; (2) general safety; (3) drafting tools and lines; (4) architect's scale usage; (5) civil engineer's scale usage; (6) mechanical engineer's scale usage; (7) metric scale usage; (8) graphic reproduction; (9) major drafting equipment; and (10) inking tools and techniques. Each unit contains the following: (1) unit and specific objectives; (2) suggested activities; (3) instructional materials; (4) unit content; (5) references; (6) instructor notes; (7) information sheets; (8) lessons; (9) transparency masters; (10) handouts; (11) assignment sheets; (12) job sheets; and (13) unit test and answers. (NLA)

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Module

1 DRAFTING FUNDAMENTALS

70-4001-I
Instructor's Guide

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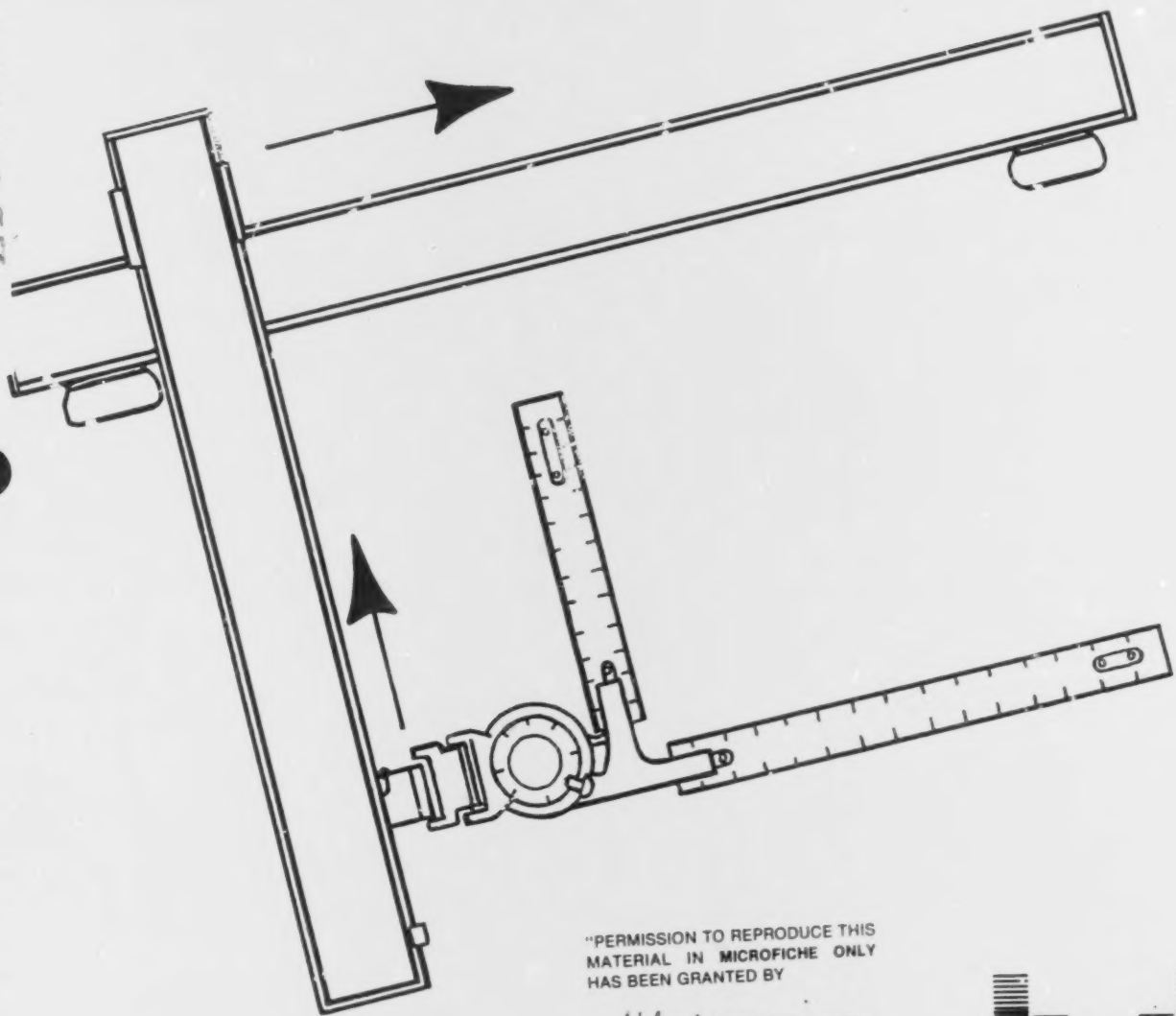

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Modules in this IML Drafting series

1: Drafting Fundamentals
2: Construction Techniques
3: Orthographic Drawings and Dimensioning
4: Related Views and Descriptive Geometry
5: Pictorial Drawings
6: Basic CAD Drawings
7: Introduction to Drafting Fields
8: Geometric Tolerancing
9: Performing Mathematical Calculations

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DRAFTING

Module 1: Drafting Fundamentals

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Columbia, MO 65211

1990

Instructor's Guide
Catalog No. 70-4001-I

FOREWORD

Once again, we are indebted to the teachers and administrators who provide their time, effort and professionalism to develop curriculum guides for trade, technical and industrial education programs. This drafting guide is an outstanding example of what can be accomplished when the right people with the right attitude get together. Committee members worked hard over several years' time in advisory, writing, technical consultation and field-test capacities.

This guide is designed to be totally integrated with the Vocational Instructional Management System. It is hoped that all guides produced under our supervision will help classroom teachers manage instruction. A curriculum guide is more than a resource--it is an integral part of the management system. Rather than impeding instruction, it should guide and facilitate instruction.

This guide's format has been set up for competency-based teaching and testing. Unit tests evaluate specific competencies and can be used with the Vocational Administrative Management System (VAMS). Information sheets, transparency masters, job sheets, assignment sheets and test items are keyed to specific competencies. A cross-reference table has been included to identify quickly the parts of the curriculum that relate to specific competencies. The material has also been packaged for students.

Although this guide may be a new format for some teachers, we are confident that, when used as designed, time spent by teachers and students will become more productive. Any future drafting curriculum modifications will begin with this guide. The drafting field is undergoing constant and considerable change. We will annually evaluate the need to update this guide on a module-by-module basis. Your suggestions regarding areas for improvement are both encouraged and appreciated.

Judith Moore, supervisor
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Department of Elementary and Secondary Education

Charles "Chuck" Waibel, director
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Department of Elementary and Secondary Education

ACKNOWLEDGMENTS

This drafting guide represents a continuing commitment to Missouri's Vocational Instructional Management System (VIMS). The guide has been keyed to the drafting competency profile developed by industry and education professionals in the state.

When searching for current drafting materials to adopt or utilize in the guide's development, comparable materials were found from the Mid-America Vocational Curriculum Consortium (MAVCC), of which Missouri is a member. MAVCC materials, therefore, have been relied upon as a resource for this guide. A debt of thanks is owed to the entire MAVCC organization for the research and development of these drafting materials.

Special appreciation is given to the writers (Chuck Berendzen, Earl Cross, Ken Franken, Milton Moore, Greg Peck, Kelli Schulte, J. Hunter, Mike Starr, Richard Faber and Robert Fine) for their self-motivation, reliability and technical expertise.

Support and contributions of IML staff members were instrumental to this module's development.

Harley Schlichting, director
Amon Herd, associate director
Phyllis Miller and Dan Stapleton, assistant directors
Ann Techau, assistant editor
Sharon Dyer, graphic designer
Lori Holliday, word processor

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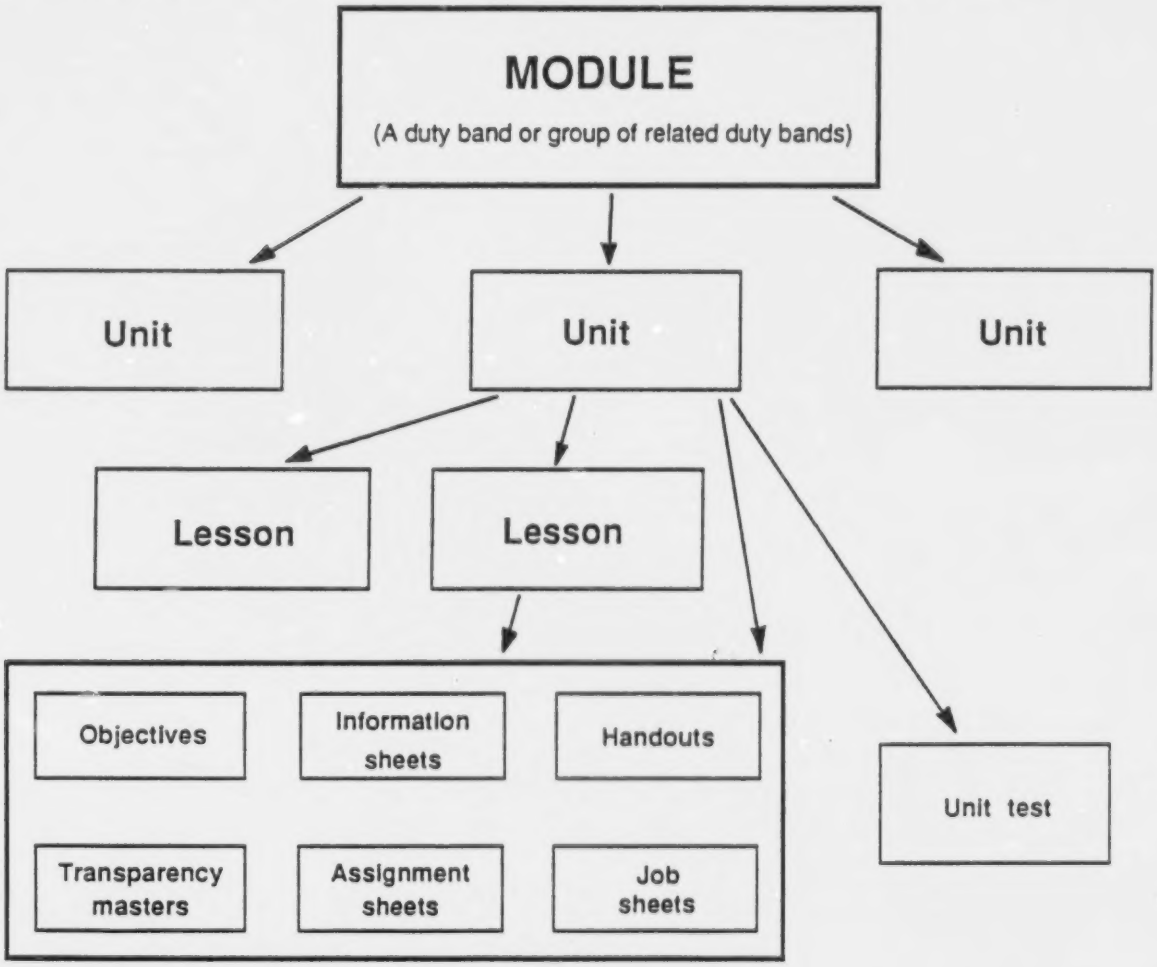
HOW TO USE THIS PUBLICATION

GUIDE COMPONENTS

Units of instruction

This Drafting guide contains ten modules of instruction. Within each module are instructional units including some or all of the following components: performance objectives, information sheets, transparency masters, handouts, assignment sheets, job sheets and a unit test. Special instructions on audiovisuals, supplies, etc. are included in the Notes to the Instructor section near the beginning of each unit.



Competency profile

On the Missouri competency profile, tasks are divided into general subject areas, or duty bands, which are identified by a capital letter. Under each duty band are related tasks (competencies), which are identified by an Arabic numeral. To evaluate the student on performance of the competencies, a 3-2-1-N grading system is used, where:

- 3 = **Mastery** - can work independently with no supervision
- 2 = **Requires supervision** - can perform job completely with limited supervision
- 1 = **Not mastered** - requires instruction and close supervision
- N = **No exposure** - no experience or knowledge in this area

Cross-reference table (color-coded white)

Once the numbering system is understood, this table quickly reveals how the instructional components of the module relate to Missouri competencies. On the competency profile, tasks are divided into general subject areas, or duty bands, which are identified by a capital letter. Under each duty band are related tasks (competencies), which are identified by an Arabic numeral.

On the cross-reference table, unit numbers are represented by Roman numerals (I, II, III, etc.). Lessons within a unit are shown with Arabic numerals. Therefore, the first objective in Lesson 1 is numbered 1.1, the second is 1.2, and so on. Other components of the module (transparencies, handouts, assignment sheets and job sheets) also use this numbering system. By looking at the cross-reference table, the instructor can quickly determine what test questions or job sheets a student needs to receive an evaluation on a particular competency.

Objectives (color-coded white)

Each unit is based on performance objectives which state the measurable unit and specific behavioral or performance objectives that students are expected to achieve. Since the objectives of the unit provide direction for the teaching-learning process, it is important for the teacher and students to have a common understanding of the objectives. Teachers should feel free to add/adapt objectives which will fit the material to student and community needs. Supporting material will, of course, need to be added for any new objectives.

Table of contents, references, notes to the instructor (color-coded pink)

These pages have been coded pink for instructor use only. The reference section lists materials used as sources in developing the material. Special instructions on audiovisuals, supplies, etc. are included in the Notes to the Instructor section.

Information sheets (green)

Presented in outline form for clarity, these pages provide content essential for meeting the cognitive (knowledge) objectives in the unit. Students should study the information sheets before class discussion or completion of assignment sheets. **CAUTION** statements indicate possible equipment damage, while **WARNING** statements recommend procedures to avoid bodily injury. Handouts and transparency masters are noted in the information sheets for instructional use.

Transparency masters (white)

Transparencies provide information by visually reinforcing or clarifying ideas presented in the information sheets. They are effective when identification is necessary and they direct the students to the topic of discussion. Transparencies should be left on the screen only when topics shown are under discussion.

Handouts (white)

Whenever more detailed information than can be presented in a transparency is needed, a handout is used. Handouts give the students additional information that can be kept with their class notes or student references.

Assignment sheets (tan)

Assignment sheets furnish paper-and-pencil practice to develop the knowledge necessary as a prerequisite to skill development. They can be given to students for class completion or used as homework assignments. Answer sheets (color-coded pink) can be used by the student or instructor to check progress.

Job sheets (blue)

These evaluation instruments are provided for two purposes: to outline steps of procedure and to check student performance mastery. Job sheets begin with a list of tools and materials needed for the activity. Job sheets furnish potential employers with a picture of skills being taught and performance which might be reasonably expected from a vocational student. The spaces to the right of the page on a job sheet

assist the instructor in evaluating a student on a particular activity. This 3-2-1-N grading system is the same as the one used on the competency profile.

Unit test (yellow)

Competency-based tests are designed to help eliminate subjective testing and to improve student evaluation and accountability. Specific competencies and test questions are linked on the answer key. These unit tests have been written to be used with computerized VAMS (Vocational Administrative Management System), utilizing Scantron sheets for computer-recording of test answers.

The unit test may be eliminated if the competency was thoroughly evaluated by job sheets. However, an emphasis should be placed on cognitive as well as performance skills. If the objective or competency will be evaluated by a job sheet, it is often necessary to determine by a written test whether the student understands enough of the material to perform the job sheet.

SUGGESTED ACTIVITIES

The following list of suggested activities may be helpful, especially to the beginning instructor.

1. Provide students with objective sheet and information sheets.
2. Discuss unit and specific objectives.
3. Discuss information sheets, assignment sheets and/or job sheets, lesson-by-lesson.
4. Have students do assignment sheet(s) to satisfactory levels.
5. Give students unit test.
6. After successful completion of the test, have students do job sheet(s).

Students should perform the following activities.

1. Read objective sheet.
2. Study information sheets.
3. Do assignment sheet(s).
4. Take unit test.
5. Do job sheets.

PACKAGING

This Drafting guide has been packaged with the entire class in mind. For the teacher, a complete instructor's guide contains all ten modules. In the student reference, selected portions have been reproduced for student use (objectives page, information sheets, handouts). Student work sheets (assignment sheets, job sheets, unit tests) have been packaged together for student distribution as the instructor deems necessary.

In the student reference, page numbers do not run consecutively because some pages have been removed that appear only in the instructor's guide.

Drafting

Module: Drafting Fundamentals

Cross-Reference Table of Instructional Materials

Competency	Unit	Instructional Objective	Transparency Master	Handout	Assignment Sheet	Job Sheet	Test Item	Notes
A-1	II	2.1-2.2	1-10				1-30	
A-3	I	1.6					1-20	
A-4	I	1.2-1.5	1,2				1-20	
A-6	I	1.1					1-20	
B-1	III	3.1-3.16	1-14		1-11		1-49	
B-2	III	3.17-3.24			1-11		1-49	
	IV	4.1-4.14	1-7		1-6		1-39	
	V	5.1-5.5	1,2		1-7		1-4	
	VI	6.1-6.5	1		1-5		1-12	
	VII	7.1-7.12	1-3		1-7		1-33	
	X	10.1-10.7	1-3		1-4	1-4	1-34	
B-3	VIII	8.1-8.2	1		1	1	1-12	
B-6	IX	9.1-9.15	1-5		1-3	1-2	1-60	

INTRODUCTION TO DRAFTING
UNIT I

UNIT OBJECTIVE

After completion of this unit, the student should be able to define drafting, select areas of specialization within the drafting profession, and name areas in which a drafter and a drawing will be evaluated. The student should also be able to develop an organizational chart for a typical engineering department. This knowledge will be evidenced by correctly performing the procedures outlined in the assignment sheet and by scoring 85 percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms related to drafting with their correct definitions.
2. Write a definition of drafting.
3. Select areas of specialization in the drafting profession.
4. List industries that employ drafters.
5. Name related ocupational fields that employ drafters.
6. Match job descriptions with their correct job titles.
7. Arrange in order the sequence for the completion of drafting work.
8. Match job classifications within a manufacturing structure with their correct definitions.
9. Distinguish between the advantages and disadvantages of a drafting occupation.
10. Select minimum qualifications for a drafter trainee, drafter, designer, licensed engineer, and licensed architect.
11. Select personal traits that are important for a successful drafter.
12. Select five related skills important for a successful drafter.
13. Name areas in which a drafter will be evaluated.
14. Name areas in which a drawing will always be evaluated.
15. Define the abbreviations of professional drafting organizations.
16. Name advantages enjoyed by drafters who join a professional organization.
17. Develop an organizational chart for a typical engineering department.

INTRODUCTION TO DRAFTING
UNIT I

SUGGESTED ACTIVITIES

I. Provide student with objective sheet.

II. Provide student with information and assignment sheets.

III. Make transparencies.

IV. Discuss unit and specific objectives.

V. Discuss information and assignment sheets.

VI. Take students on a field trip to visit an industry related to drafting.

VII. Encourage students to interview a person who works as a drafter and report their findings to the class.

VIII. Discuss in detail the advantages and disadvantages of being a drafter.

IX. Invite speakers who have experience in various drafting fields to speak to the class about their jobs.

X. Provide a list of drafting vocabulary words.

XI. Discuss appropriate student organizations such as VICA.

XII. Give test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

A. Objective sheet

B. Information sheet

C. Transparency masters

1. TM 1--Types of Drafting
2. TM 2-Drafting Industries
3. TM 3--Typical Organizational Chart

D. Assignment Sheet #1-Develop an Organizational Chart For a Typical Engineering Department

E. Answers to assignment sheet

F. Test

G. Answers to test

II. References:

A. Brown, Walter C. *Drafting for Industry*. South Holland, IL: Goodheart-Willcox Company, Inc., 1974.

B. Dygdon, John Thomas and Henry Cecil Spencer. *Basic Technical Drawing*. New York 10022: Macmillan Publishing Co., Inc., 1968.

C. Giesecke, Frederick E., et al. *Technical Drawing*. New York, 10022: Macmillan Publishing Company, Inc., 1980.

D. Jensen, Cecil and Helsel, Jay. *Engineering Drawing and Design*. New York,: Gregg Division/McGraw-Hill Book Company, 1979.

E. Spence, William P. *Drafting Technology and Practice*. Peoria, IL 61614: Chas. A. Bennett Company, Inc., 1973.

MODULE: DRAFTING FUNDAMENTALS

UNIT I: INTRODUCTION TO DRAFTING

UNIT OBJECTIVE

After completion of this unit, the student should be able to identify drafting occupations and related fields, and drafting terminology. The student should also be able to identify standards organizations from their abbreviations. This knowledge will be evidenced by scoring _____ percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1.1 Match terms related to drafting with their correct definitions.

1.2 Select areas of specialization in the drafting profession.

1.3 Name related occupational fields that employ drafters.

1.4 Match job descriptions with their correct job titles.

1.5 Distinguish between the advantages and disadvantages of a drafting occupation.

1.6 Define the abbreviations of standards organizations.

CONTENTS OF THIS UNIT

A. Objective sheet

B. References

C. Notes to the instructor

D. Lesson plans

1. Lesson 1: INTRODUCTION TO THE DRAFTING PROFESSION

   a. Information outline

   b. Transparency masters

      TM 1.1: Types of Drafting
      TM 1.2: Typical Organization Chart

E. Unit test

F. Answers to unit test

REFERENCES

1. Brown, Walter C. Drafting for Industry. South Holland, IL: Goodheart-Wilcox Company, Inc., 1974.

2. Davis, Ronald, Bill Hill, and Bruce Yancey. Basic Drafting: Book One. Stillwater, Okla., 74074: Mid-American Vocational Curriculum Consortium, Inc., 1981.

3. Dygdon, John Thomas and Henry Cecil Spencer. Basic Technical Drawing. New York 10022: Macmillan Publishing Co., Inc., 1968.

4. Giesecke, Frederick E., et al. Technical Drawing. New York, 10022: Macmillan Publishing Company, Inc., 1980.

5. Jensen, Cecil and Helsel, Jay. Engineering Drawing and Design. New York: Gregg Division/McGraw-Hill Book Company, 1979.

6. Spence, William P. Drafting Technology and Practice. Revised ed. Pittsburg, Kan. 66762: Bennett & McKnight Publishing Company, 1980.

7. Wallach, Paul Ross. Drafting Problems, 2nd ed. Mission Hills, CA 91345: Glencoe Publishing Company, 1988.

NOTES TO THE INSTRUCTOR

A. Suggested approaches to teaching this unit

1. Discuss in detail the advantages and disadvantages of being a drafter.

2. Invite speakers who have experience in various drafting fields to speak to the class about their jobs.

3. Have each student select an area of specialization from the Related Fields Category and write why it is of interest to them.

4. Take students on a field trip to visit an office that employs drafting professionals.

MODULE: DRAFTING FUNDAMENTALS

UNIT I: INTRODUCTION TO DRAFTING

LESSON 1: INTRODUCTION TO THE DRAFTING PROFESSION

I. Terms and definitions

A. **Cartography**--the art of map making

B. **Craftsworker**--a skilled worker who practices a trade; a specialist in an area of construction or manufacturing

C. **Drafting**--the process of taking the ideas, sketches and specifications of designers and engineers and preparing drawings to scale, using standard symbols and approved drafting techniques so that a product can be made

D. **Engineering**--the application of science and mathematics in making structures, machines, products, systems, and processes useful to humanity

E. **Estimating**--cataloging and pricing all materials needed to build a product

F. **Technical**--having to do with the practical, industrial or mechanical arts or the applied sciences

G. **Technician**--a specialist in the technical details of a particular subject

II. Areas of specialization in the drafting profession (TM 1.1)

A. Machine
B. Structural
C. Piping
D. Electrical
E. Aircraft
F. Architectural
G. Electronic
H. Civil
I. Computer graphics
J. Sheet metal
K. Others

III. Related occupational fields that employ drafters

A. Estimating--Cost analysis

B. Inspection--Quality control

C. Model fabrication

D. Surveying

E. Engineering aid

F. Sales--Drafting equipment and reproduction

G. Commercial artists

H. Cartography

I. Numeric control programming

IV. Job descriptions and job titles (TM 1.2)

A. Trainee

1. Traces or copies drawings made by others
2. Revises drawings, working from instructions
3. Repairs or redraws damaged drawings

B. Junior drafter

1. Corrects and revises drawings
2. May make simple detail and assembly drawings

C. Drafter

1. Draws detail and assembly drawings
2. Works with reference material
3. Makes routine calculations
4. Takes field notes

D. Senior drafter

1. Handles design drafting detail assignments
2. Exercises considerable judgment in layout
3. Makes or reviews many calculations

E. Checker

1. Checks all final drawings for errors
2. Is directly responsible for errors
3. Routes drawings through the department

F. Junior designer

1. Works from engineering notes and specifications
2. Does calculations
3. Has some supervisory duties
4. Handles complete design assignment with minimum supervision

G. Senior designer

1. Works with engineering staff

2. Works with mathematics, strength of materials, gear ratios, and drive systems

3. Generally, will have a college degree in engineering or drafting technology

4. May coordinate production deadlines, cost analysis, and generally manage the drafting department

H. Chief drafter

1. Responsible for all drafting in a company

2. In charge of hiring and firing

3. Sets work schedules, company drafting standards, and work loads

4. Responsible for budgeting and purchasing for the needs of drafting department

V. Advantages and disadvantages of a drafting occupation

A. Advantages

1. Clean indoor working conditions

2. Open job market

3. Lots of overtime available

4. Sense of self-satisfaction and pride

5. Stepping stone for higher paying occupations

6. Variety of challenging assignments

7. Involved in designing new products

8. Opportunity to see jobs through to completion

9. Work with state-of-the-art equipment

10. Opportunity for advancement to other fields--such as designing or engineering

11. Good pay

12. Opportunity to work with both management and production people

13. Receive credit for your work

14. Opportunity to work in many different technical fields

B. Disadvantages

1. Confinement to one area

2. Long hours at times of peak production

3. Responsible to both management and production

4. Rigid accountability for accuracy of work
5. Knowledge of many technical fields required
6. Very little physical exercise
7. Rigid time limits for doing work

VI. Abbreviations of standards organizations and their meanings

A. ANSI--American National Standards Institute

B. ISO--International Organization for Standardization

C. SAE--Society of Automotive Engineers

D. MIL-STD--Military Standards

TYPES OF DRAFTING

Aircraft

Architectural

Civil

Computer Graphics

Electrical

Electronic

Machine

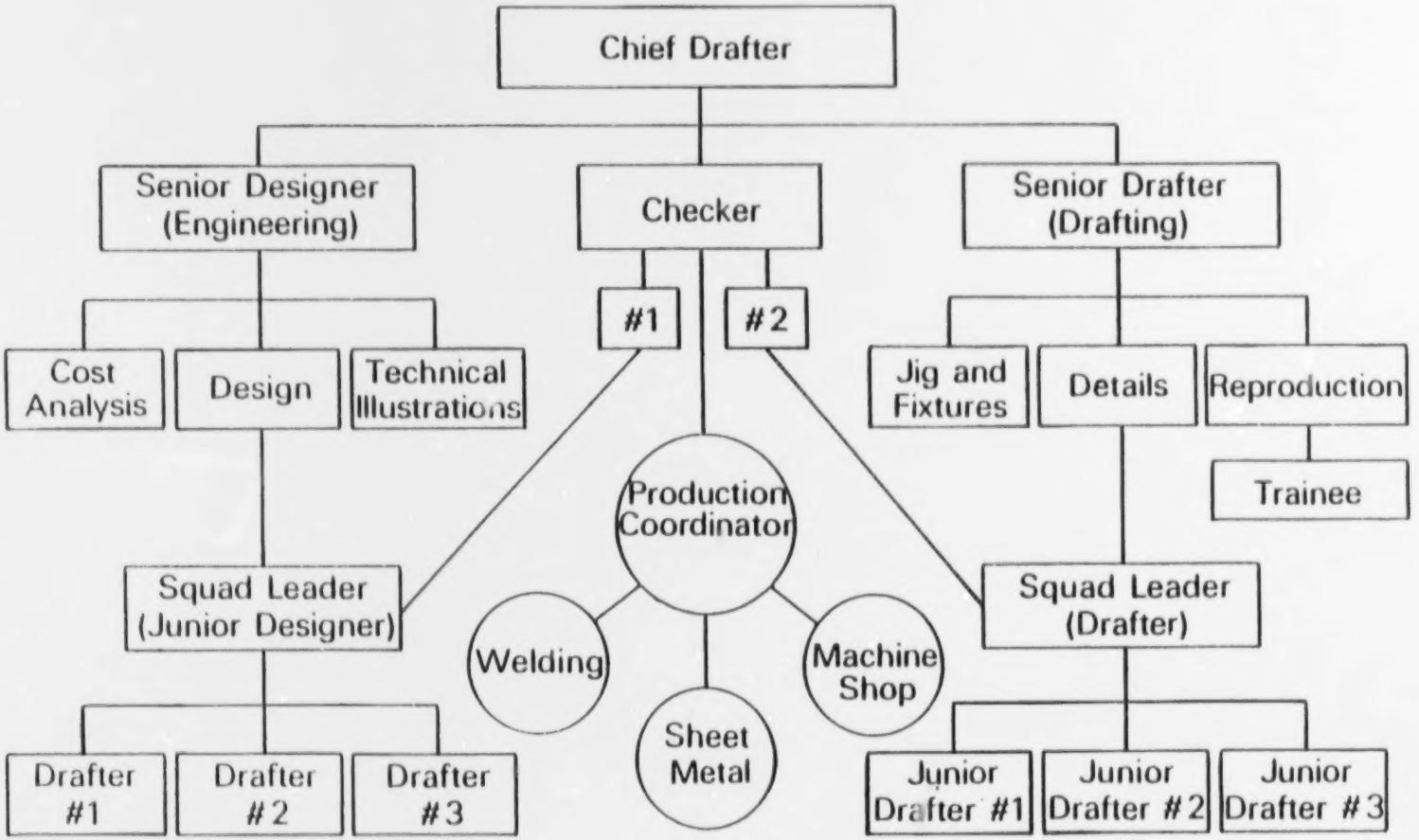
Piping

Sheet Metal

Structural

Others

TYPICAL ORGANIZATION CHART



TM 1.2

11

MODULE: DRAFTING FUNDAMENTALS

UNIT I: INTRODUCTION TO DRAFTING

UNIT TEST

Match the terms on the right with their correct definitions on the left.

____	1.	Cataloging and pricing all materials needed to build a product	a. Technical
____	2.	The application of science and mathematics in making structures, machines, products, systems, and processes useful to humanity	b. Engineering
____	3.	A skilled worker who practices a trade; a specialist in an area of construction or manufacturing	c. Technician
____	4.	Having to do with the practical, industrial, or mechanical arts or the applied sciences	d. Craftsworker
____	5.	The art of map making	e. Cartography
____	6.	A specialist in the technical details of a particular subject	ab. Estimating
____	7.	Process of preparing drawings to scale using approved drafting techniques	ac. Drafting

Choose the option which best answers the question or completes the statement.

____ 8. Which item is <u>not</u> an area of specialization in the drafting profession?

a. Piping
b. Aircraft
c. Political science
d. Electronic
e. Architectural

____ 9. Which item is a disadvantage of a drafting occupation?

a. Clean indoor working conditions
b. Open job market
c. Confinement to one area
d. Variety of challenging assignments
e. Stepping stone for higher paying occupations

Match the job titles on the right with their correct descriptions on the left.

____	10.	Traces or copies drawings made by others; revises drawings, working from instructions, and repairs or redraws damaged drawings	a. Trainee b. Junior drafter c. Senior drafter d. Checker e. Junior designer ab. Senior designer ac. Chief drafter ad. Drafter
____	11.	Checks all final drawings for errors, is responsible for errors and routes drawings through the department	
____	12.	Handles design drafting detail assignments, exercises considerable judgment in layout and makes or reviews many calculations	
____	13.	Works with engineering staff; works mathematics, strength of materials, gear ratios, and drive systems; generally, will have a college degree in engineering or drafting technology; and may coordinate production deadlines, cost analysis, and generally manage the drafting department	
____	14.	Works from engineering notes and specifications, does calculations, has some supervisory duties, and handles complete design assignment with minimum supervision	
____	15.	Responsible for all drafting in a company; in charge of hiring and firing; sets work schedules, company drafting standards, and work loads; and responsible for budgeting and purchasing for the needs of drafting department	
____	16.	Corrects and revises drawings and may make simple detail and assembly drawings	
____	17.	Draws detail and assembly drawings, works with reference material, makes routine calculations and takes field notes	

18. **Define the abbreviations of the professional standards organizations listed below.**

a. ANSI _____
b. ISO _____
c. SAE _____
d. MIL-STD _____

19. **Name five related occupational fields that employ drafters.**

a. _____
b. _____
c. _____
d. _____
e. _____

20. **Define drafting.**

ANSWERS TO UNIT I TEST

1. ab (A6)
2. b (A6)
3. d (A6)
4. a (A6)
5. e (A6)
6. c (A6)
7. ac (A6)
8. c (A4)
9. c (A4)
10. a (A4)
11. d (A4)
12. c (A4)
13. ab (A4)
14. e (A4)
15. ac (A4)
16. b (A4)
17. ad (A4)

18. a. American National Standards Institute (A3)
    b. International Organization for Standardization
    c. Society of Automotive Engineers
    d. Military Standards

19. Any five of the following: (A4)
    a. Estimating--Cost Analysis
    b. Inspection--Quality Control
    c. Model Fabrication
    d. Surveying
    e. Engineering Aid
    f. Sales--Drafting Equipment and Reproduction
    g. Technical Illustration
    h. Cartography

20. The process of taking the ideas, sketches and specifications of designers and preparing drawings to scale, using standard symbols and approved drafting techniques so that a product can be made (A6)

NOTE: The number in parentheses after each answer indicates the competency that question evaluates.

MODULE: DRAFTING FUNDAMENTALS

UNIT II: GENERAL SAFETY

UNIT OBJECTIVE

After completion of this unit, the student should be able to identify safety procedures of the school, instructor and students. The student should also be able to list ten specific rules for personal safety. This knowledge will be evidenced by correctly performing the procedures outlined on the assignment sheets and by scoring _____ percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

2.1 Identify safety procedures of the school, instructor, and student.

2.2 List ten specific rules for personal safety in the drafting classroom.

CONTENTS OF THIS UNIT

A. Objective sheet

B. References

C. Notes to the instructor

D. Lesson plans

1. Lesson 1: SAFETY RULES AND RESPONSIBILITIES

a. Information outline

b. Transparency masters

TM 2.1: Do not Misuse Electrical Tools
TM 2.2: Use Trimming Shears, Papers Cutters, and Metal Straight Edges Properly and Only for Intended Purposes
TM 2.3: Handle Sharp, Pointed Instruments With Care
TM 2.4: Avoid Horseplay
TM 2.5: Keep All Four Feet of Drafting Stools on Floor
TM 2.6: Use Both Hands to Raise and Lower Drafting Table Tops
TM 2.7: Use Reproduction Equipment With Proper Care
TM 2.8: Do Not Throw Any Objects
TM 2.9: Tag Any Defective Electrical Equipment With a "Do Not Use" Tag
TM 2.10: Follow All Rules and Regulations of the School Completely

c. Assignment sheets

AS 2.1: Copy of Safety Pledge for Vocational Drafting

E. Unit test

F. Answers to unit test

REFERENCES

1. Davis, Ronald, Bill Hill, and Bruce Yancey. Basic Drafting: Book One. Stillwater Okla., 74074: Mid-America Vocational Curriculum Consortium, Inc., 1981.

2. Noll, Robert F. Safety in the Drafting Room: Safety Education Data Sheet #95, Chicago, Ill. 60611: National Safety Council.

3. An Accident Prevention Program for School Shops and Laboratories. Washington, D.C.: Office of Education/U.S. Department of Health, Education, and Welfare.

4. Federal Register. Vol. 36. Number 105. Part II. Department of Labor, May 29, 1971.

5. Safety Practices and Procedures in School Shops. Division of Vocational Education/New Jersey Department of Education.

6. A Look at Service Safety. Tecumseh, Mich.: Tecumseh Products Co.

NOTES TO THE INSTRUCTOR

A. Suggested approaches to teaching this unit

1. Show a safety film.

2. Discuss evacuation plan.

3. Have a fire and disaster drill.

B. Suggested supplemental materials

1. Film: "Housekeeping Means Safekeeping." 146-009. Journal Films, 930 Pinter Avenue, Evanston, Ill. 60202.

2. Film: "Stop a Fire Before it Starts." 146-024, Journal Films, 909 Diversey Parkway, Chicago, Ill. 60614.

MODULE: DRAFTING FUNDAMENTALS

UNIT II: GENERAL SAFETY

LESSON 1: SAFETY RULES AND RESPONSIBILITIES

I. Safety responsibilities of school, instructor, and student

A. School

1. Provide adequate facilities (including a classroom large enough to accommodate students without crowding)

2. Provide modern, up-to-date equipment and working conditions

3. Provide adequate facilities for good lighting and temperature controls

B. Instructor

1. Provide a well-organized, progressive instructional program that challenges all students (thus eliminating free time when horseplay and unsafe acts commonly occur)

2. Provide a well-planned cleanup program with individual assignments

NOTE: It's a good idea to rotate cleanup duties weekly

3. Provide adequate instruction in the safe use and proper care of all drafting and reproduction equipment

4. Provide plans for students to follow in emergency situations

5. Provide an accident reporting system which insures fast and efficient help in case of accident

C. Student

1. Be responsible for own area and equipment and see that it is kept clean and in good working condition

2. Report any safety hazard to instructor immediately

3. Do not abuse or misuse any piece of equipment in the classroom

4. Conduct oneself in a manner conducive to safe practice

II. Specific rules for personal safety in the drafting classroom (TM 2.1 - TM 2.10)

A. Do not misuse electrical tools

NOTE: Report all electrical failures immediately

B. Use trimming shears, paper cutters and metal straight edges only for intended purposes

NOTE: Do not remove guard from paper cutter

C. Handle sharp, pointed instruments with care

NOTE: Never throw a compass or a divider--dividers, compasses, ruling pens and pencils are sources of puncture wounds

D. Avoid horseplay--a playful push may cause a bad cut or bruise from contact with the sharp edge of a piece of furniture or equipment

NOTE: More accidents result from horseplay than any other single cause

E. Keep all four feet of drafting stools on the floor

NOTE: Leaning back and tilting a drafting stool is a dangerous practice

F. Use both hands to raise and lower drafting table tops

NOTE: Instructor should supervise adjustments of drafting tables--be prepared to hold table top as control rod knobs are loosened--fingers must be kept clear of the top and hinged area

G. Use reproduction equipment with proper care and only after instruction in its use and with instructor's permission to use it

NOTE: Means must be provided for eyewash equipment

H. Do not throw any object

I. Tag any defective electrical equipment with a "Do Not Use" tag and turn it in to instructor

J. Follow all rules and regulations of the school

K. Adequate clearance around drafting tables must be kept according to fire and safety regulations

L. Stools and chairs must be kept out of aisles and placed under tables and desks when not in use

M. Drafting machine arms, T-square blades, and other equipment must not block aisles

N. Points of thumb tacks often break off from the head and remain sticking out of the drafting board. These points should be removed immediately from the board as they may cause injury to the hands. Tape is recommended for mounting paper on drafting boards

O. Pencils, erasers, and other small articles should be picked up from the floor in order to prevent them from becoming the cause of a serious fall

P. Pencils, thumb tacks, and other small articles should not be placed or held in the mouth --these items may be swallowed or cause injury and infection

Q. Chemicals must be kept away from the eyes, nose, and throat and should be used only in an area where adequate ventilation can be provided

R. Always keep hands and fingers clear of the papercutter blade

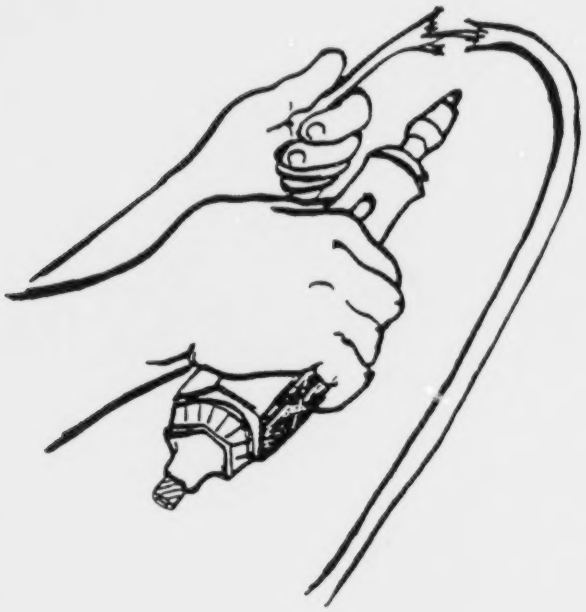
S. The blade of the paper cutter must be kept in the "down" position when the paper cutter is not in use

T. Hands must be kept clear of the light tube and belt-feeding mechanism of the Diazo whiteprinter in order to avoid crushed fingers

U. Articles and materials must be stored in proper lockers and shelves--items placed on top of lockers may fall and injuries may occur

V. Any injury, no matter how slight, should be reported to the instructor immediately--infection can result from uncared for minor cuts and scratches

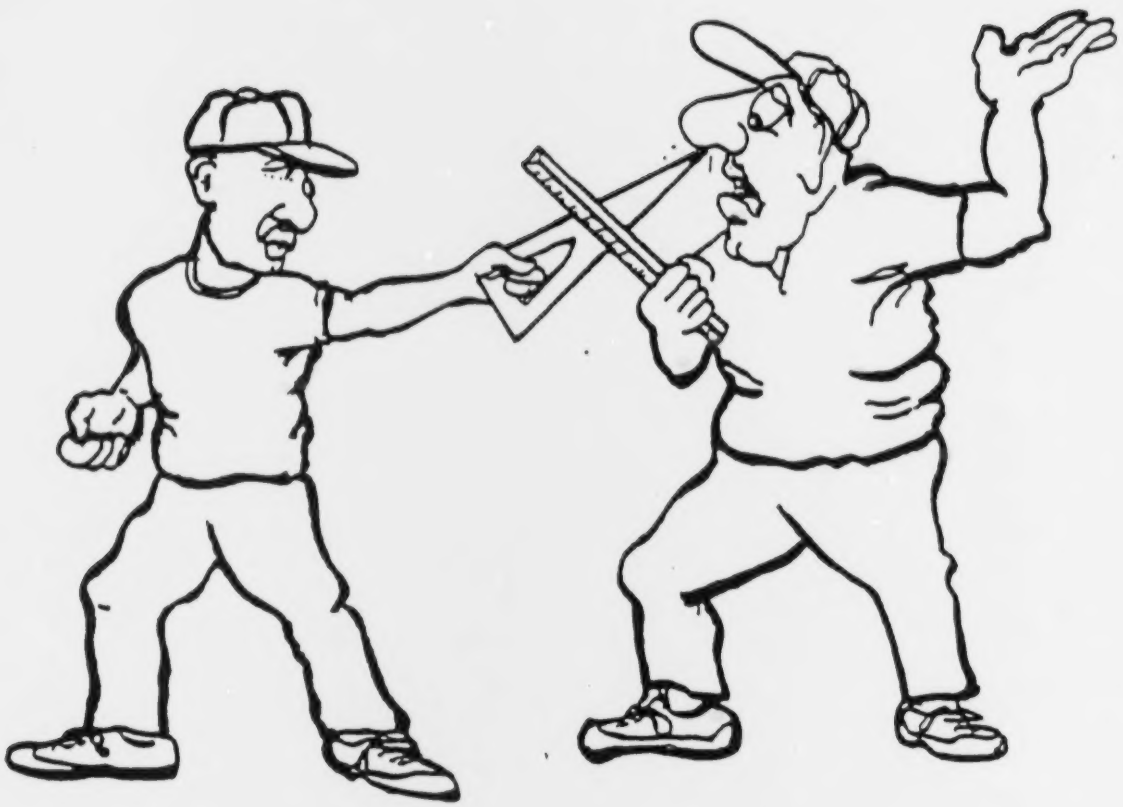
DO NOT MISUSE ELECTRICAL TOOLS



USE METAL STRAIGHT EDGES PROPERLY AND ONLY FOR INTENDED PURPOSES

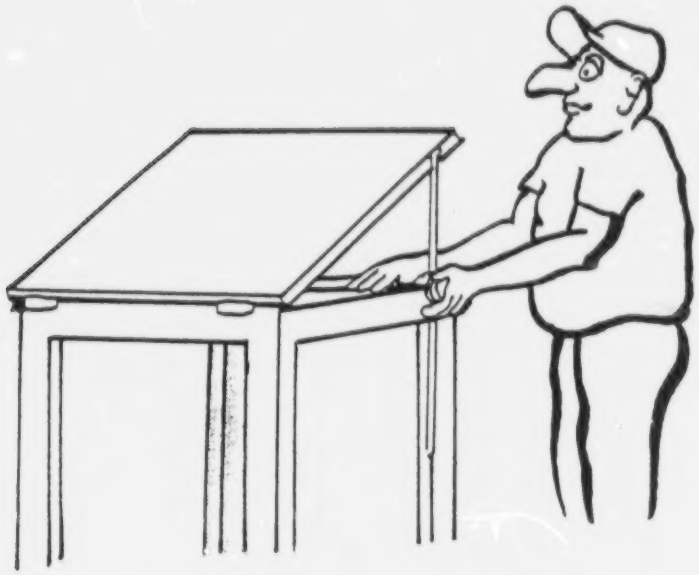
HANDLE SHARP POINTED INSTRUMENTS WITH CARE

AVOID HORSEPLAY



KEEP ALL FOUR FEET OF DRAFTING STOOLS ON THE FLOOR

USE BOTH HANDS TO RAISE AND LOWER DRAFTING TABLE TOPS

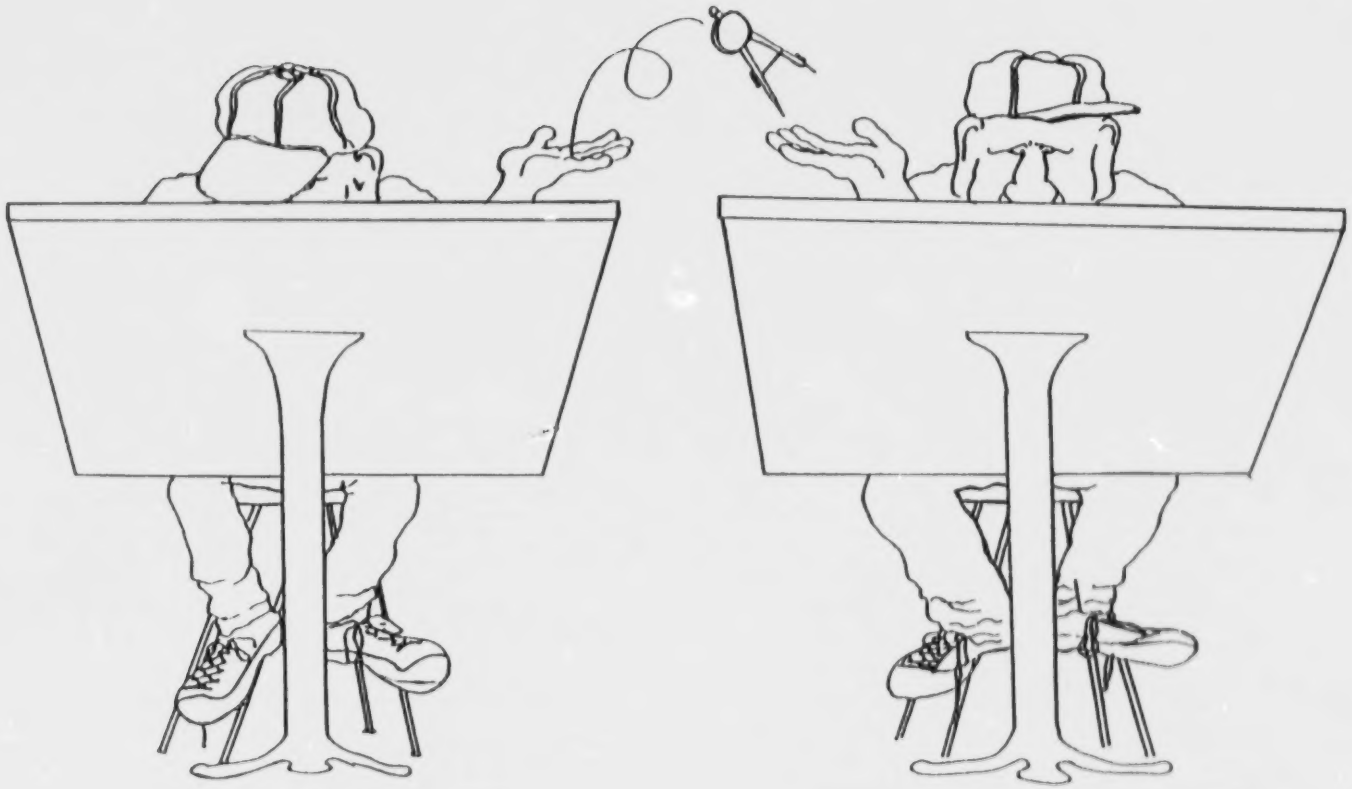


USE REPRODUCTION EQUIPMENT WITH PROPER CARE

Correct

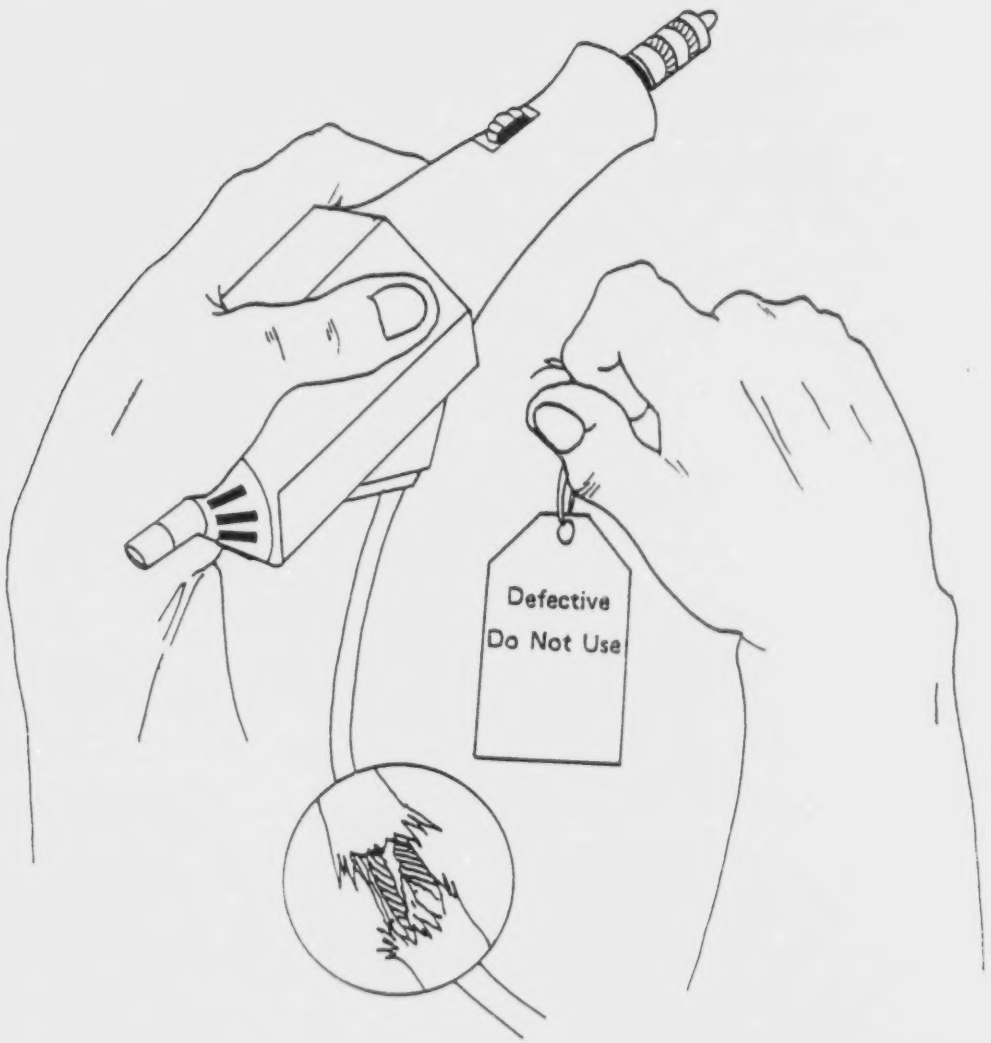
Incorrect

DO NOT THROW ANY OBJECTS



TM 2.8

TAG ANY DEFECTIVE ELECTRICAL EQUIPMENT WITH A "DO NOT USE" TAG



FOLLOW ALL RULES AND REGULATIONS OF THE SCHOOL COMPLETELY

SAFETY PLEDGE FOR VOCATIONAL DRAFTING

_____, who is enrolled in Vocational Drafting at _____, will as a part of his/her shop experience, operate machines and instruments, providing that his/her parent or guardian gives written permission.

It is understood that each student will be given proper instruction, both in the use of the equipment and in the correct safety procedures concerning it, before being allowed to operate it himself/herself. The student must assume responsibility for the following safe practices, and we therefore ask that he/she subscribe to the following safety pledge.

1. I PROMISE TO ABIDE BY ALL SAFETY RULES FOR THE SHOP AS FOLLOWS:

   a. To not misuse electrical tools
   b. To use trimming shears, paper cutters, and metal straight edges only for their intended use
   c. To handle sharp pointed instruments with care
   d. To avoid horseplay
   e. To keep all four legs of drafting stools on the floor
   f. To use both hands to raise and lower drafting table tops
   g. To use reproduction equipment with proper care and only after instruction in its use and with the instructor's permission to use it
   h. To not throw any object
   i. To tag any defective electrical equipment with a "Do Not Use" tag and turn it in to the instructor
   j. To follow all rules and regulations of the school

2. I WILL REPORT ANY ACCIDENT TO THE TEACHER IMMEDIATELY.

DATE _____ STUDENT'S SIGNATURE _____

I hereby give consent to allow my son/daughter to operate all machines and equipment necessary in carrying out the requirements of the course in which he/she is enrolled.

DATE _____ PARENT'S SIGNATURE _____
(Required according to school policy)

(**NOTE**: Parents are cordially invited to visit the school to inspect the Drafting Lab at any time.)

Student File Copy

SAFETY PLEDGE FOR VOCATIONAL DRAFTING

_____, who is enrolled in Vocational Drafting at _____, will as a part of his/her shop experience, operate machines and instruments, providing that his/her parent or guardian gives written permission.

It is understood that each student will be given proper instruction, both in the use of the equipment and in the correct safety procedures concerning it, before being allowed to operate it himself/herself. The student must assume responsibility for the following safe practices, and we therefore ask that he/she subscribe to the following safety pledge.

1. I PROMISE TO ABIDE BY ALL SAFETY RULES FOR THE SHOP AS FOLLOWS:

   a. To not misuse electrical tools
   b. To use trimming shears, paper cutters, and metal straight edges only for their intended use
   c. To handle sharp pointed instruments with care
   d. To avoid horseplay
   e. To keep all four legs of drafting stools on the floor
   f. To use both hands to raise and lower drafting table tops
   g. To use reproduction equipment with proper care and only after instruction in its use and with the instructor's permission to use it
   h. To not throw any object
   i. To tag any defective electrical equipment with a "Do Not Use" tag and turn it in to the instructor
   j. To follow all rules and regulations of the school

2. I WILL REPORT ANY ACCIDENT TO THE TEACHER IMMEDIATELY.

DATE _____ STUDENT'S SIGNATURE _____

I hereby give consent to allow my son/daughter to operate all machines and equipment necessary in carrying out the requirements of the course in which he/she is enrolled.

DATE _____ PARENT'S SIGNATURE _____
(Required according to school policy)

(**NOTE**: Parents are cordially invited to visit the school to inspect the Drafting Lab at any time.)

Teacher File Copy

MODULE: DRAFTING FUNDAMENTALS

UNIT II: GENERAL SAFETY

UNIT TEST

Identify safety responsibilities of the school, instructor, and student by placing in the appropriate blanks an "a" to indicate school responsibilities, a "b" to indicate instructor responsibilities, and a "c" to indicate student responsibilities.

____ 1. Provide adequate facilities, including a classroom large enough to accommodate students without crowding

____ 2. Be responsible for own area and equipment and see that it is kept in good working condition

____ 3. Conduct oneself in a manner conducive to safe practices

____ 4. Provide a well-organized, progressive, instructional program that challenges all students, thus eliminating free time when horseplay and unsafe acts commonly occur

____ 5. Provide plans for students to follow in emergency situations

____ 6. Provide adequate facilities for good lighting and temperature controls

____ 7. Do not abuse or misuse any piece of equipment in the classroom

____ 8. Provide adequate instruction in the safe use and proper care of all drafting and reproduction equipment

____ 9. Provide a well-planned cleanup program with individual assignments

____ 10. Report any safety hazard to instructor immediately

____ 11. Provide modern, up-to-date equipment and working conditions

____ 12. Provide an accident reporting system which insures fast and efficient help in case of accident

13. **List seven specific rules for personal safety in the drafting classroom.**

a. _____

b. _____

c. _____

d. _____

e. _____

f. _____

g. _____

ANSWERS TO UNIT II TEST

1. a
2. c
3. c
4. b
5. b
6. a
7. c
8. b
9. b
10. c
11. a
12. b

13. Any of the following rules:
    a. Do not misuse electrical tools.
    b. Use trimming shears, paper cutters and metal straight edges only for intended purposes.
    c. Handle sharp, pointed instruments with care.
    d. Avoid horseplay.
    e. Keep all four feet of drafting stools on the floor.
    f. Use both hands to raise and lower drafting table tops.
    g. Use reproduction equipment with proper care and only after instruction in its use and with the instructor's permission to use it.
    h. Do not throw any object.
    i. Tag any defective electrical equipment with a "Do Not Use" tag and turn it in to instructor.
    j. Follow all rules and regulations of the school.
    k. Keep adequate clearance around drafting tables.
    l. Keep stools and chairs out of aisles and placed under table and desks when not in use.
    m. Drafting machine arms, T-square blades and other equipment must not block aisles.
    n. Remove broken points of thumb tacks from the drafting board immediately.
    o. Pick up pencils, erasers and other small articles from the floor to prevent them from causing someone to fall.
    p. Pencils, thumb tacks, and other small articles should not be placed or held in the mouth.
    q. Chemicals must be kept away from the eyes, nose, and throat; and should be used only in an area where adequate ventilation can be provided.
    r. Always keep hands and fingers clear of the paper-cutter blade.
    s. The blade of the paper cutter must be kept in the "down" position when the paper cutter is not in use.
    t. Hands must be kept clear of the light tube and belt-feeding mechanism of the Diazo whiteprinter in order to avoid crushed fingers.
    u. Articles and materials must be stored in proper lockers and shelves.
    v. Any injury, no matter how slight, should be reported to the instructor immediately.

MODULE: DRAFTING FUNDAMENTALS

UNIT III: DRAFTING TOOLS AND LINES

UNIT OBJECTIVE

After completion of this unit, the student should be able to identify basic drafting tools, demonstrate the ability to use various drafting tools and properly care for them. The student should also be able to name the types and sizes of lines, list the uses of lead, plastic lead, and ink, and relate grades of lead to their uses. This knowledge will be evidenced by correctly performing the procedures outlined on the assignment and job sheets and by scoring _____ percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

3.1 Match terms related to basic tools and lines with their correct definitions.

3.2 Identify the angles found on the two standard triangles.

3.3 State the purpose for using a standard triangle.

3.4 List three types of compasses.

3.5 Identify the three types of dividers.

3.6 List four types of irregular curves.

3.7 List five types of common templates.

3.8 Identify tools used to erase and/or clean a drawing surface.

3.9 Select true statements concerning rules for maintenance and care of drafting tools and equipment.

3.10 Name three types of drafting pencils.

3.11 List the sizes of thin-lead mechanical pencils.

3.12 Match the types of lead with the devices used to sharpen them.

3.13 Name the 18 grades of pencil leads from hard to soft.

3.14 Distinguish between the advantages and disadvantages of ink, lead, and plastic lead.

3.15 Match lead, plastic lead, and ink with their comparable reproduction qualities.

3.16 Describe non-reproducible lead.

3.17 Draw lines on a drawing medium using lead and plastic lead.

3.18 Sharpen a compass lead or mechanical lead-holder lead with a conical or a wedge point.

3.19 Divide a circle into 24 parts of 15° by using the 30°/60° and 45° triangle.

3.20 Use a compass to draw circles and arcs.

3.21 Use a divider.

3.22 Measure angles with a protractor.

3.23 Use an irregular curve to construct a curved line.

3.24 Construct circles and arcs using a template.

3.25 Identify the basic types of lines.

3.26 Construct a drawing with mechanical pencils.

3.27 Construct a drawing with technical ink pens.

3.28 Construct a tracing using reproduction techniques and materials.

MODULE: DRAFTING FUNDAMENTALS

UNIT III: DRAFTING TOOLS AND LINES

CONTENTS OF THIS UNIT

A. Objective sheet

B. References

C. Notes to the Instructor

D. Lesson plans

1. Lesson 1: BASIC TOOLS, LEADS AND LINES

a. Information outline

b. Transparency masters

TM 3.1: Standard Triangles
TM 3.2: Adjustable Triangles
TM 3.3: Three Types of Compasses
TM 3.4: Three Types of Dividers
TM 3.5: Tools Used to Erase and/or Clean a Drawing Surface
TM 3.6: Types of Drafting Pencils
TM 3.7: Pencil Lead Grades
TM 3.8: Section Lines and Center Lines
TM 3.9: Extension, Dimension, and Leader Lines
TM 3.10: Cutting Plane Lines and Short-Break Lines
TM 3.11: Long-Break Lines and Phantom Lines
TM 3.12: Phantom, Stitch, Chain, and Border Lines
TM 3.13: Section, Extension, Dimension, and Leader Lines
TM 3.14: Cutting Plane, Short Break, and Long Break Lines

c. Assignment sheets

AS 3.1: Draw Lines on a Drawing Medium Using Graphite and Plastic Lead
AS 3.2: Sharpen a Compass Lead or Mechanical Lead-holder Lead with a Conical or a Wedge Point
AS 3.3: Divide a Circle into 24 Parts of 15° Using the 30°/60° and 45° Triangle
AS 3.4: Use a Compass to Draw Circles and Arcs
AS 3.5: Use a Divider
AS 3.6: Measure Angles with a Protractor
AS 3.7: Use an Irregular Curve to Construct a Curved Line
AS 3.8: Construct Circles and Arcs Using a Template
AS 3.9: Construct a Drawing Using Mechanical Pencils
AS 3.10: Construct a Drawing Using Technical Ink Pens
AS 3.11: Construct a Drawing Using Reproduction Techniques and Materials

E. Unit test

F. Answers to unit test

REFERENCES

1. French, Thomas E. and Carl L. Svenson. Mechanical Drawing. Dallas, Texas. Webster Division, McGraw-Hill Company, 1966.

2. Davis, Ronald, Bill Hill, and Bruce Yancey. Basic Drafting Book One and Book Two. Stillwater, Okla. 74074: Mid-America Vocational Curriculum Consortium, Inc., 1981.

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7. Wright, Lawrence S. Drafting Technical Communication. Bloomington, Ill.: McKnight and McKnight Publishing Company, 1968.

8. American National Standards Institute. Line Conventions and Lettering. New York: The American Society of Mechanical Engineers, 1979.

9. Vocational Curriculum Development and Research Center. Basic Drafting. Natchitoches, La. 71457: State of Louisiana Vocational Curriculum Development and Research Center, revised 1979.

NOTES TO THE INSTRUCTOR

A. Suggested approaches to teaching this unit

   1. Demonstrate the use of instruments and equipment.

MODULE: DRAFTING FUNDAMENTALS

UNIT III: DRAFTING TOOLS AND LINES

LESSON 1: BASIC TOOLS, LEADS AND LINES

I. Terms and definitions

A. **Cleaning pad**--a loosely woven bag of ground art gum eraser used to remove loose graphite from a drawing

B. **Compass**--an instrument used to draw circles and arcs

C. **Divider**--an instrument used to transfer dimensions

D. **Drafting tape**--a specially prepared tape that does not harm the surface of the table or drawing media

E. **Dust cover**--a covering used to protect drawings and equipment when not in use

F. **Dusting brush**--a tool used to brush loose graphite and eraser dust from a drawing

G. **Eraser**--a devise used to remove pencil lines and graphite smudges from a drawing

H. **Erasing shield**--a metal plate with various slots and openings used to protect linework when a portion of the drawing is to be erased

I. **Ink**--composed mainly of carbon in colloidal suspension, (latex or solutions of special shellac) and gum--the fine particles of carbon give the deep, dark, black appearance to the ink, and the gum makes it quick to dry and waterproof

J. **Irregular curve**--an instrument used to lay out any noncircular curve

K. **Lead cleaner**--a styrofoam pad or tissue paper used to remove loose graphite from a pencil lead after it has been sharpened

L. **Lead pointer**--a sharpening device for mechanical pencil leads

M. **Lead**--made of graphite with kaolin (clay) added in varying amounts in order to make the eighteen grades from the hardest (9H) to the softest (7B)

NOTE: Grade labeling varies per the manufacturer

N. **Lettering guide**--an instrument used to lay out guidelines for lettering

O. **Mechanical lead holder**--a metal holder in which leads of various hardness can be inserted

P. **Plastic lead**--composed of varying amounts of graphite with plastic

Q. **Protractor**--an instrument used to measure angles

R. **Scale**--an instrument used to measure the length of a line

S. **Template**--a thin, flat, plastic tool with various size openings of different shapes used to expedite the drawing of standard features

T. **Triangle**--an instrument consisting of a thin, flat, right-angled piece of plastic or metal with acute angles of 45°, or 30° and 60°

II. Angles found on the two standard triangles (TM 3.1)

A. 90 degree angle

B. 30 degree angle

C. 60 degree angle

D. 45 degree angle

III. Purpose of using an adjustable triangle: To provide a straight edge for drawing vertical or inclined lines at any angle that is a multiple of 15 degrees (TM 3.2)

IV. Types of compasses (TM 3.3)

A. Friction

B. Bow

C. Beam

V. Types of dividers (TM 3.4)

A. Friction

B. Bow

C. Proportional

VI. Types of irregular curves

A. Ships curve

B. Flexible curve

C. Rule curve

D. French curve

VII. Types of common templates

A. Circle template

B. Ellipse template

C. Architectural template

D. Isometric ellipse template

E. Piping template

F. Structural steel shape template

G. Hex bolt head template

H. Thread template

I. Plumbing template

J. Civil template

NOTE: Many others may be added to this list

VIII. Tools used to erase and/or clean a drawing surface (TM 3.5)

A. Eraser

B. Eraser shield

C. Cleaning pad

D. Dusting brush

E. Electric eraser

IX. Rules for maintenance and care of drafting tools and equipment

A. Keep hands and equipment clean

B. Do not bend templates sharply

C. Keep all instruments clean and dry

D. Do not use templates or scale as a straight edge for cutting tools

E. Do not use templates as an eraser shield

F. Do not hit scales and triangles on edges

G. Do not over extend compasses and dividers

H. Clean plastic tools with soap and water only

I. Do not stick compass and divider points into scales and triangles

J. Never sharpen leads over drawing or table surface

X. Types of drafting pencils (TM 3.6)

A. Wood-cased drawing pencil

B. Mechanical pencil

C. Thin-lead mechanical pencil

NOTE: Many types of thin-lead mechanical pencils are available

XI. Sizes of thin-lead mechanical pencils

A. .03 mm

B. .05 mm

C. .07 mm

D. .09 mm

XII. Types of lead and devices used to sharpen them

A. Compass leads

1. File
2. Sandpaper pad

B. Wood-cased drawing pencil leads--Drafter's pencil sharpener

C. Mechanical lead-holder leads

1. Sandpaper-cone lead pointer
2. Metal-cutter lead pointer

XIII. Pencil lead grades (TM 3.7)

A. Hard	B. Medium	C. Soft
1. 9H	1. 3H	1. 2B
2. 8H	2. 2H	2. 3B
3. 7H	3. H	3. 4B
4. 6H	4. F	4. 5B
5. 5H	5. HB	5. 6B
6. 4H	6. B	6. 7B

XIV. Advantages and disadvantages of ink, lead, and plastic lead

A. Ink

1. Advantages

a. Reproduces a clean, dense line

b. Does not smudge

c. Revisions of original drawings can be made easily with no ghost" or damage to drawing surface

d. Ink lines are completely readable through microfilm reduction and blowback

2. Disadvantages

a. Messy

b. Hard to clean up

c. Time consuming maintenance of pens

B. Lead

1. Advantages

a. Quick

b. Easy

2. Disadvantages

a. Smudges easily

b. Leaves fuzzy lines after reproduction

c. Point dulling and breaking

C. Plastic lead

1. Advantages

a. Does not smudge as easily as lead

b. Quick

2. Disadvantages

a. Can only be used on polyester film

b. Point dulling and breaking

c. Lack of adequate opacity

d. Extremely brittle

XV. Comparable reproduction qualities of lead, plastic lead, and ink

A. Lead-Acceptable

B. Plastic lead-Good

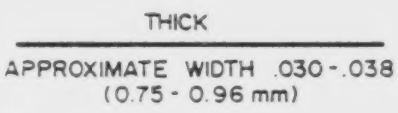
C. Ink-Excellent

XVI. Nonreproducible lead--a lead that will not reproduce by standard reproduction machines--it is used ONLY for layout work

NOTE: This lead can be obtained for a wood-cased drawing pencil, or for a .05 mm thin-lead mechanical pencil

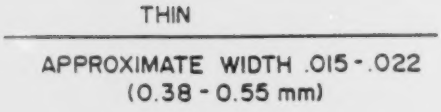
XVII. Basic types of lines (TM 3.8 - 3.12)

A. Visible lines

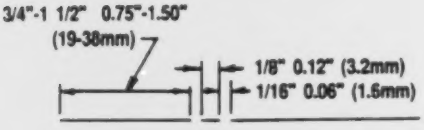


B. Hidden lines

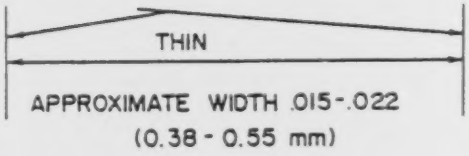
C. Section lines



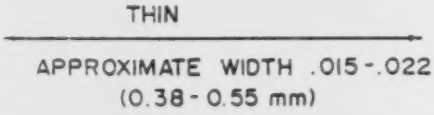
D. Center lines



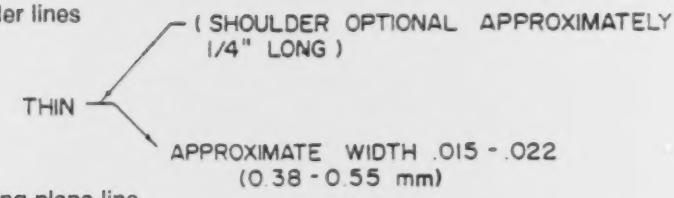
E. Extension lines



F. Dimension lines

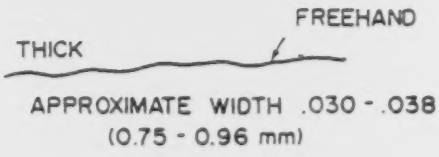


G. Leader lines

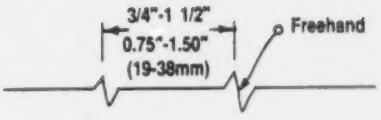


H. Cutting-plane line

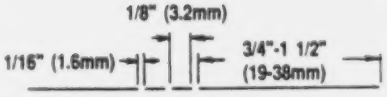
I. Short-break lines



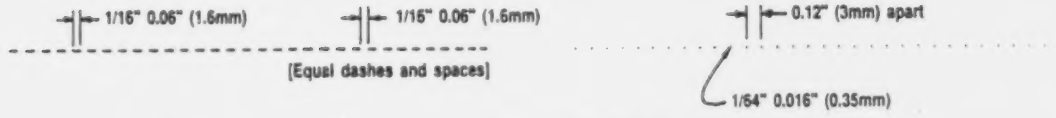
J. Long-break lines



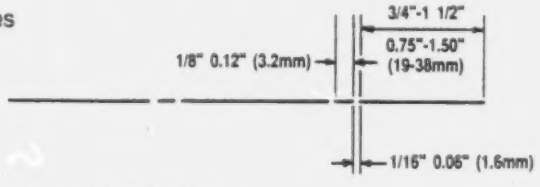
K. Phantom lines



L. Stitch lines

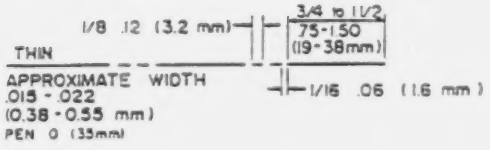


M. Border lines

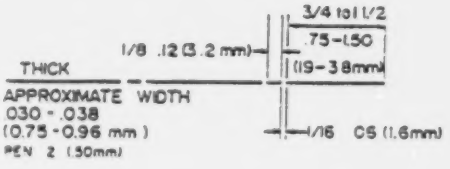


XVIII. Phantom, stitch, chain, and border lines

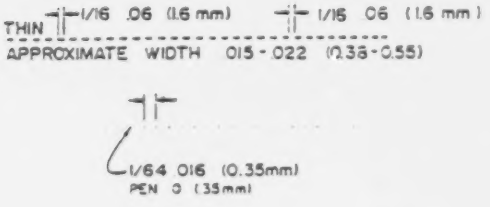
Phantom Line



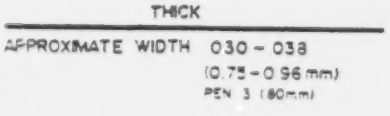
Chain Line



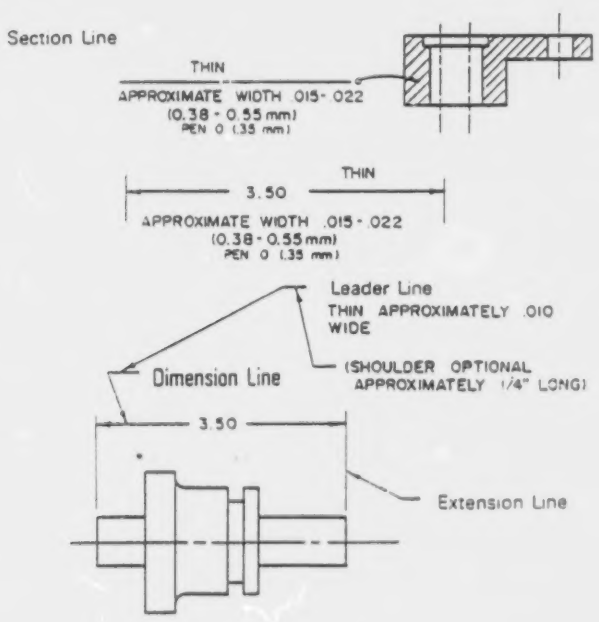
Stitch Line



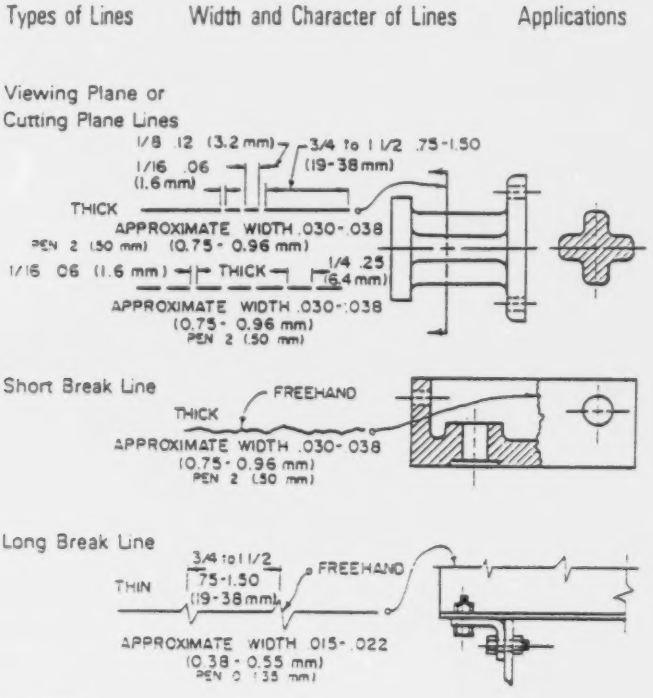
Border Line



XIX. Section, extension, dimension, and leader lines (TM 3.13)

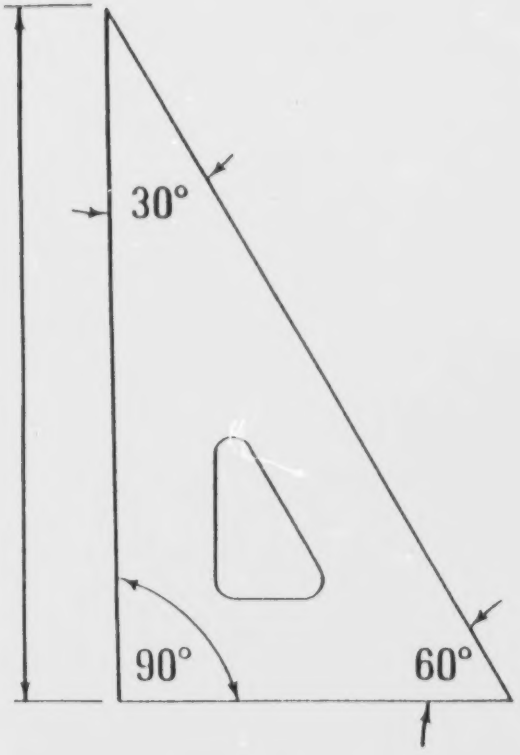


XX. Cutting plane, short break, and long break lines (TM 3.14)

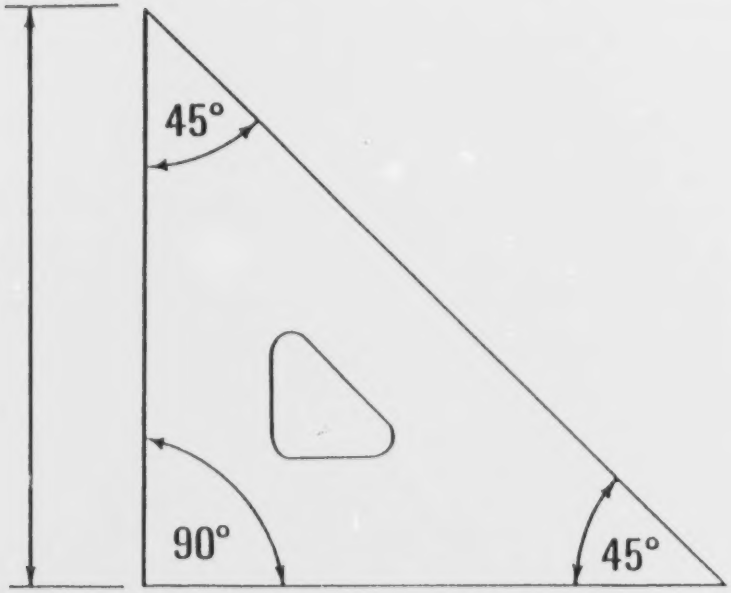


60

STANDARD TRIANGLES



61



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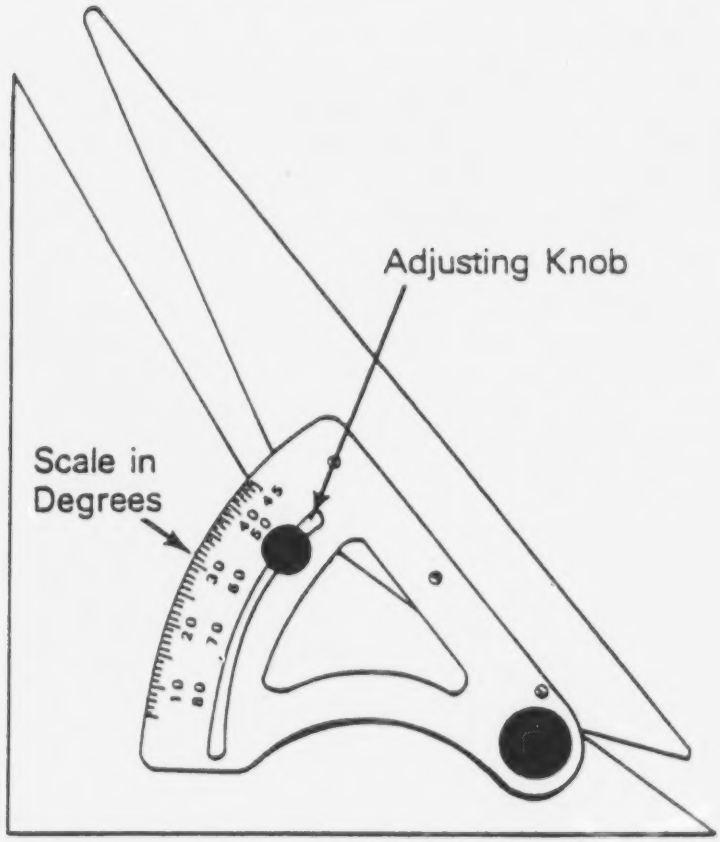
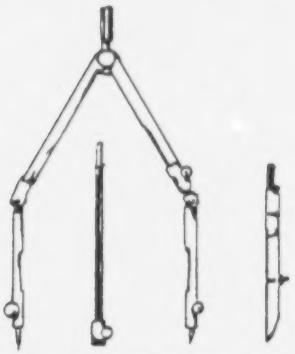
TM 3.1

ADJUSTABLE TRIANGLES



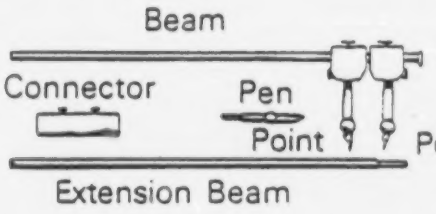
NOTE: In Closed Position
. Triangle forms Standard 45° Triangle

THREE TYPES OF COMPASSES

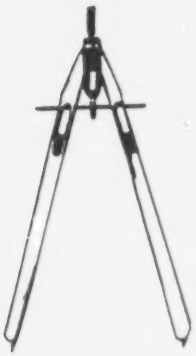


Compass, Lengthening Bar, Pen Attachment

Friction Compass

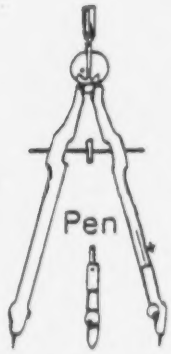


Beam Compass

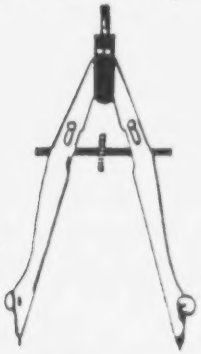


Jet Bow Compass

Ratchet Bow Compass



Bow Compass

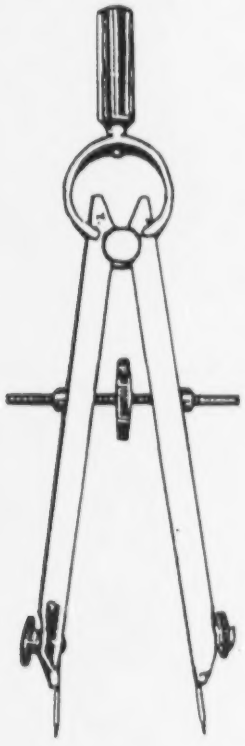


Speed Bow Compass

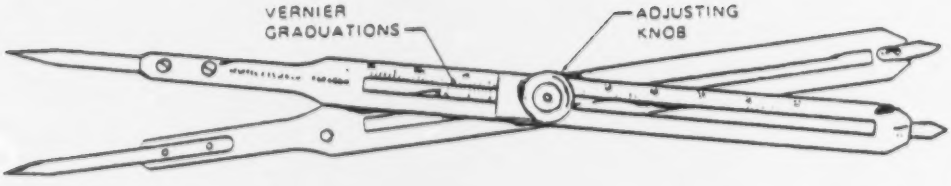
Drop Spring Bow Compass

THREE TYPES OF DIVIDERS

1. Friction Dividers

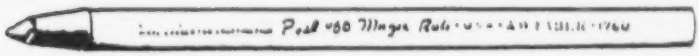


2. Bow Dividers

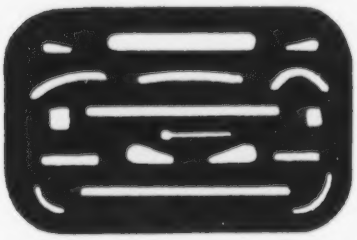


3. Proportional Dividers

TOOLS USED TO ERASE AND/OR CLEAN A DRAWING SURFACE

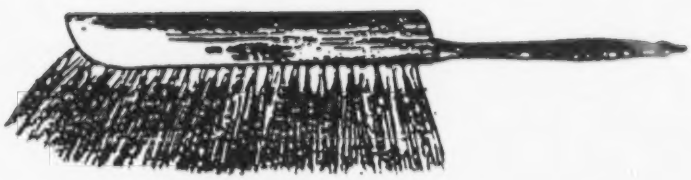


1. ERASERS

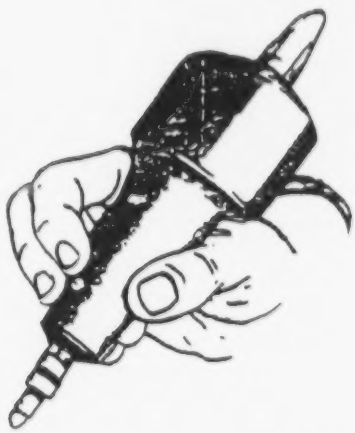


2. ERASING SHIELD

3. CLEANING PAD



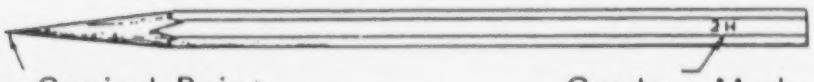
4. DUSTING BRUSH



5. ELECTRIC ERASER

TYPES OF DRAFTING PENCILS

DRAWING PENCIL



Sharp Conical Point — Grade Mark

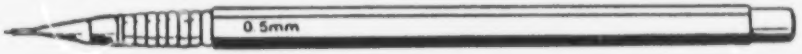
For General Linework and Lettering — *Do not sharpen this end!*

MECHANICAL PENCIL

Drafting Pencil Leads

Available in all grades

Thin - Lead Mechanical pencil



Thin Leads Require no Sharpening

PENCIL LEAD GRADES

9H 8H 7H 6H 5H 4H

Hard

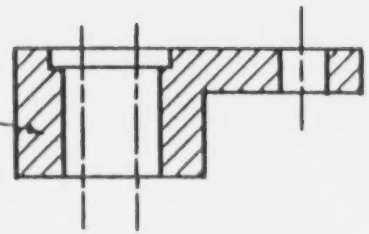
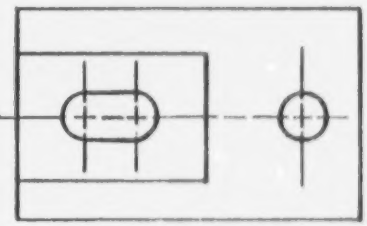
3H 2H H F HB B

Medium

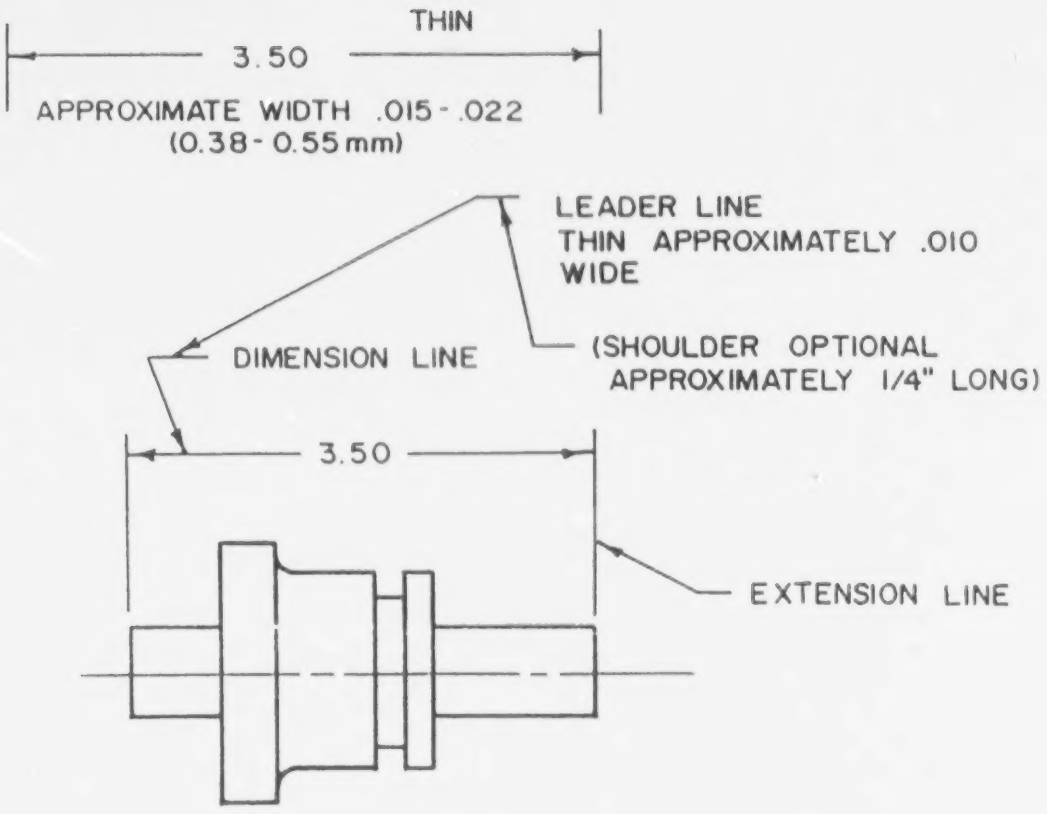
2B 3B 4B 5B 6B 7B

Soft

SECTION LINES AND CENTER LINES

LINES	WIDTH AND CHARACTER OF LINES	APPLICATIONS
SECTION LINE	THIN APPROXIMATE WIDTH .015-.022 (0.38 - 0.55 mm)	
CENTER LINE	3/4 to 1 1/2 .75-1.50 (19-38mm) 1/8 .12(3.2mm) 1/16 .06 (1.6mm) THIN APPROXIMATE WIDTH .015-.022 (0.38 - 0.55 mm)	

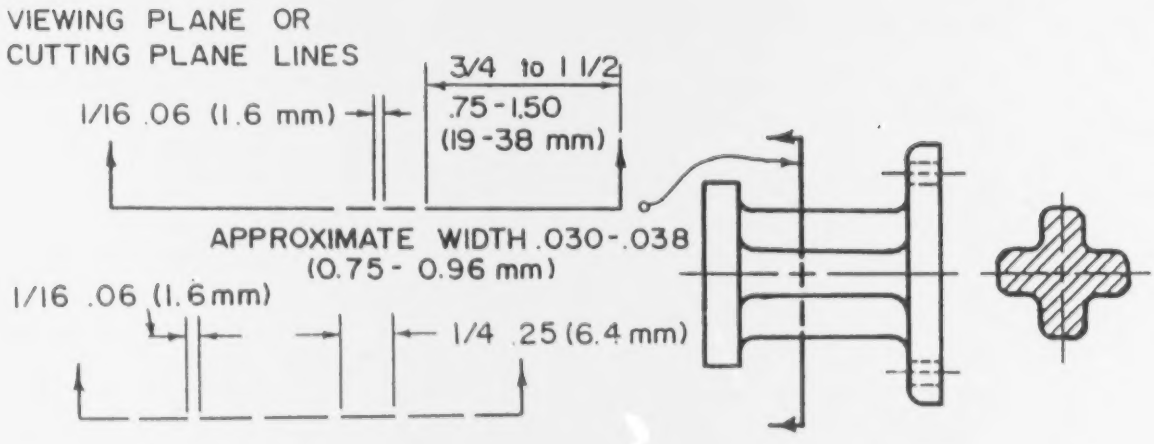
EXTENSION, DIMENSION, AND LEADER LINES

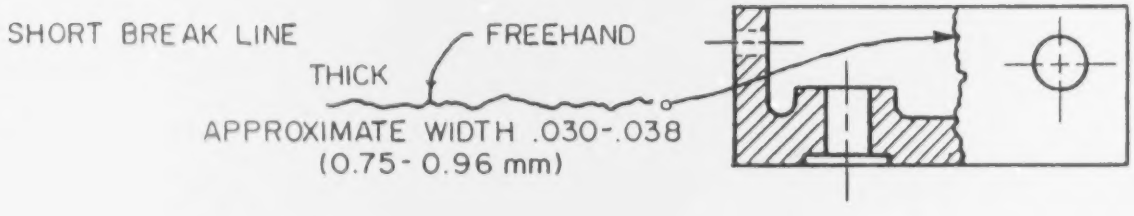


CUTTING PLANE LINES AND SHORT-BREAK LINES

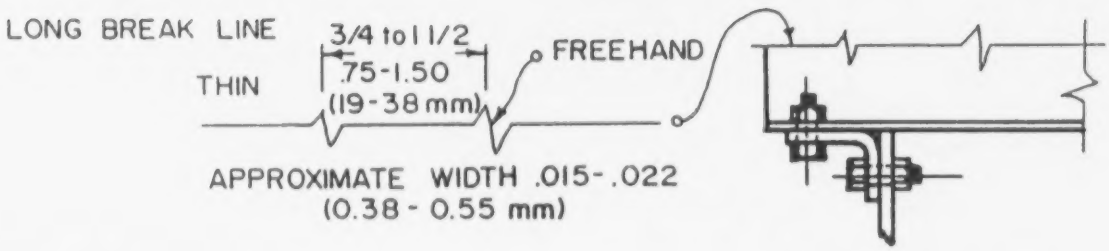
WIDTH AND CHARACTER
OF LINES

LINES APPLICATIONS

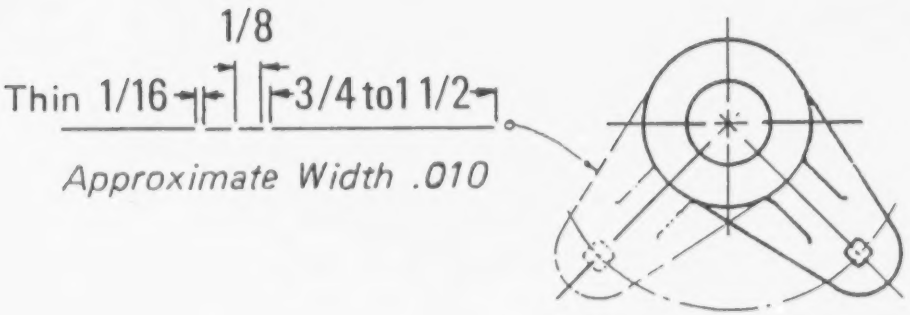




LONG-BREAK LINES AND PHANTOM LINES

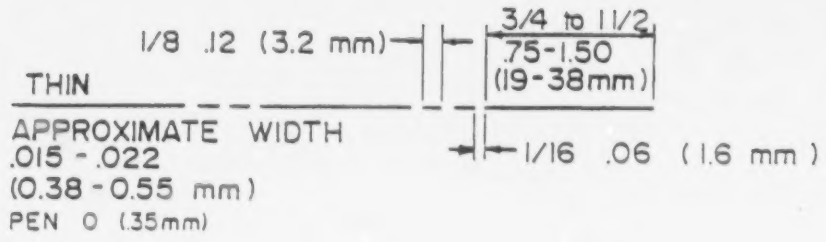


Phantom Line

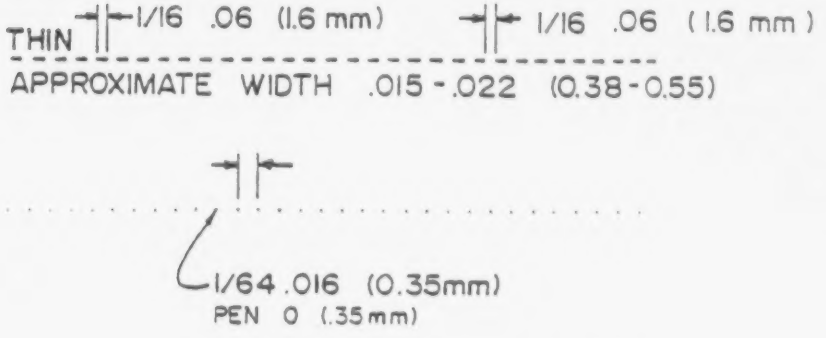


PHANTOM, STITCH, CHAIN, AND BORDER LINES

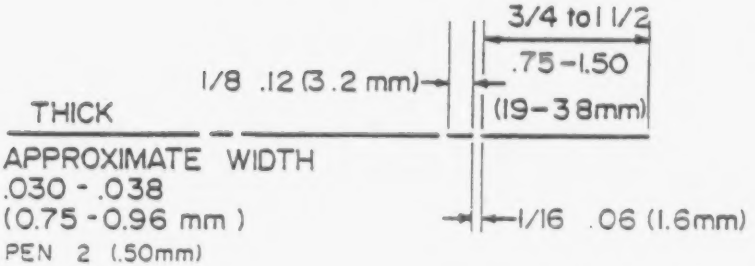
Phantom Line



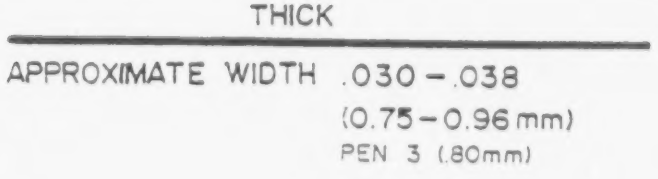
Stitch Line



Chain Line



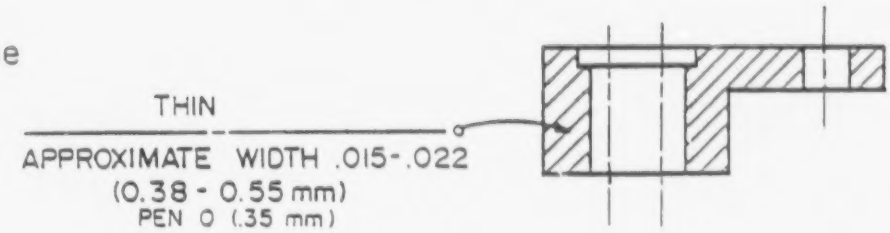
Border Line

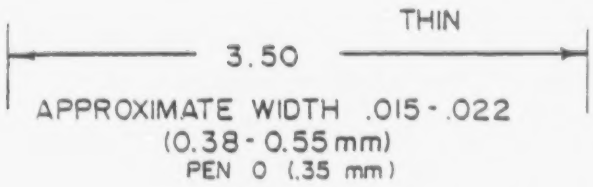


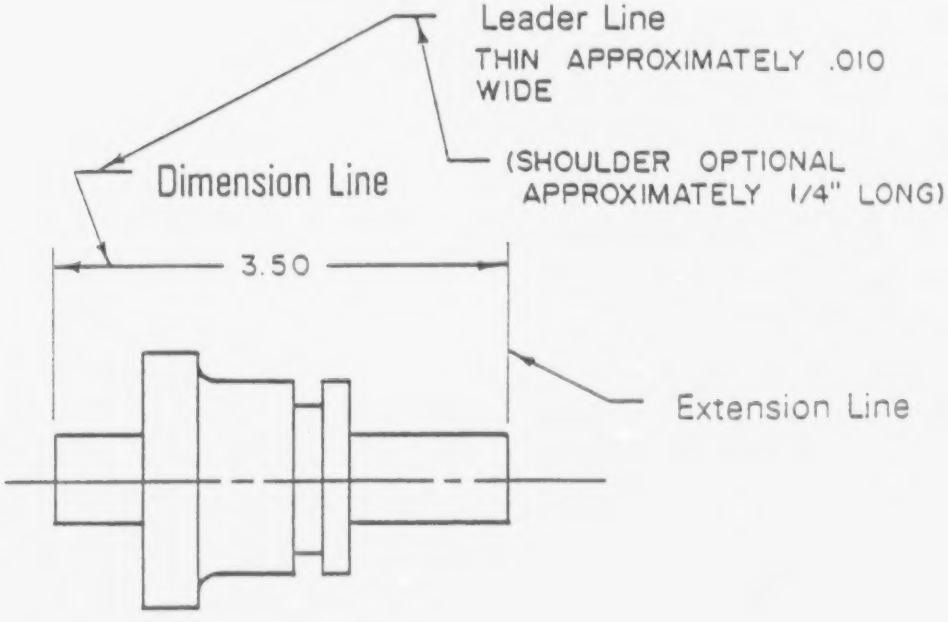
SECTION, EXTENSION, DIMENSION, AND LEADER LINES

Types of Lines Width and Character of Lines Applications

Section Line



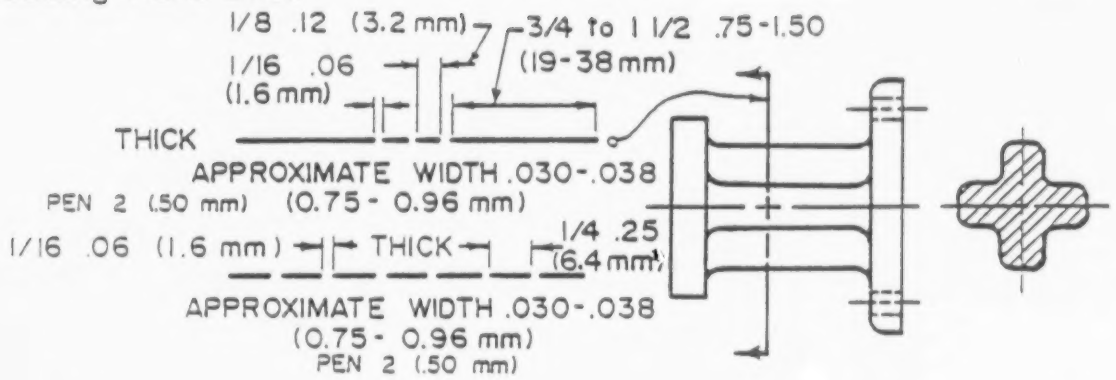




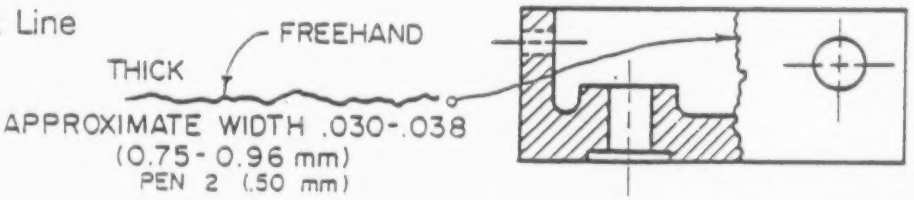
CUTTING PLANE, SHORT BREAK AND LONG BREAK LINES

Types of Lines | Width and Character of Lines | Applications

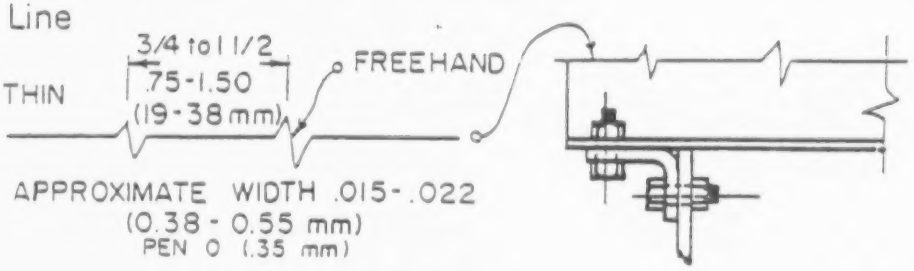
Viewing Plane or
Cutting Plane Lines



Short Break Line



Long Break Line



DRAW LINES ON A DRAWING MEDIUM USING GRAPHITE AND PLASTIC LEAD

Directions: Make three drawings.

1. Make two drawings on a sheet of vellum, one with plastic lead and one with graphite lead (size to be determined by the instructor).
2. Make one drawing on a sheet of polyester film (size to be determined by the instructor).
3. Include the complete alphabet of lines.
4. Show variations in line width.
5. Reproduce on the print machine.

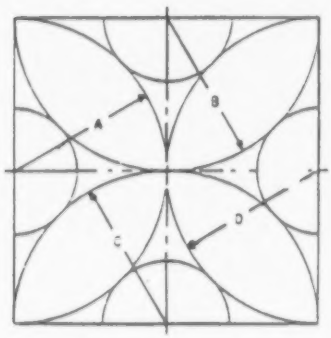


FIG. 1

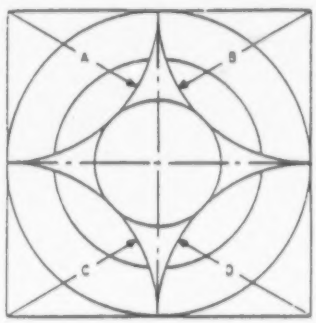


FIG. 2

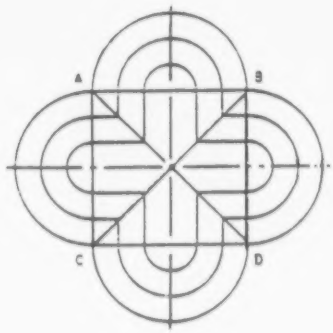


FIG. 3

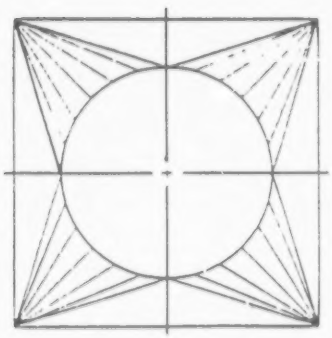


FIG. 4

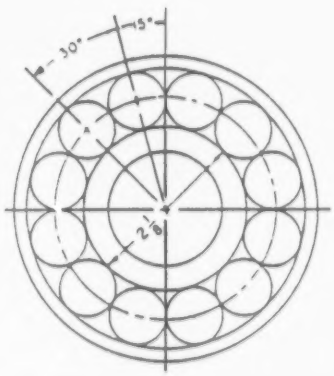


FIG. 5

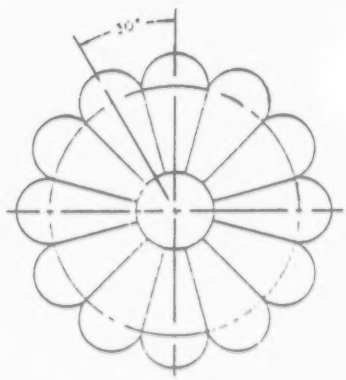


FIG. 6

SHARPEN A COMPASS LEAD OR MECHANICAL LEAD-HOLDER LEAD WITH A CONICAL OR A WEDGE POINT

Problems:

A. Directions: Sharpen a mechanical lead-holder lead. Follow the procedures outlined on this assignment sheet.

B. Directions: Sharpen a compass point. Follow the procedures outlined on this page. Procedure:

Procedure:

NOTE: A properly sharpened lead, both lead holder and compass, is extremely important because a dull lead produces fuzzy, rough lines. Only a sharp lead can produce the clean, sharp, dark lines needed for proper reproduction.

A. Sharpen a mechanical lead holder in a lead pointer (Figure 1).

1. Extend the lead approximately 1/2" out of the mechanical lead holder and insert it into the opening in the top of the lead pointer (Figure 1).

2. Rotate the lead holder in the pointer until it is sharpened into a clean, sharp point.

3. Check the point by drawing a clean, sharp line on paper.

NOTE: If the point produces a fuzzy, rough line, sharpen it again.

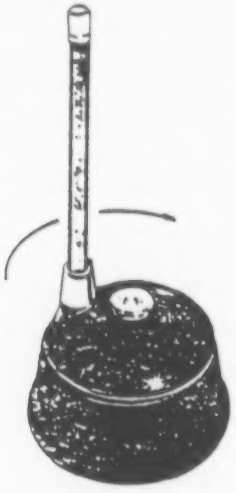


FIGURE 1

B. Sharpen a compass point

1. Extend the lead approximately 1/2" out of the compass and place it at a 30° angle on the sandpaper pad (Figure 2).

2. Move the compass lead back and forth over the sandpaper until it forms a smooth, wedge-shaped point on a long cut (Figure 2).

3. Turn the compass lead to each side at a 30° angle on the sandpaper and make smooth side cuts slightly shorter than the long cut on the wedge (Figure 2).

4. Check the point by drawing a clean, sharp line on paper.

NOTE: If the point produces a fuzzy, rough line, sharpen it again.

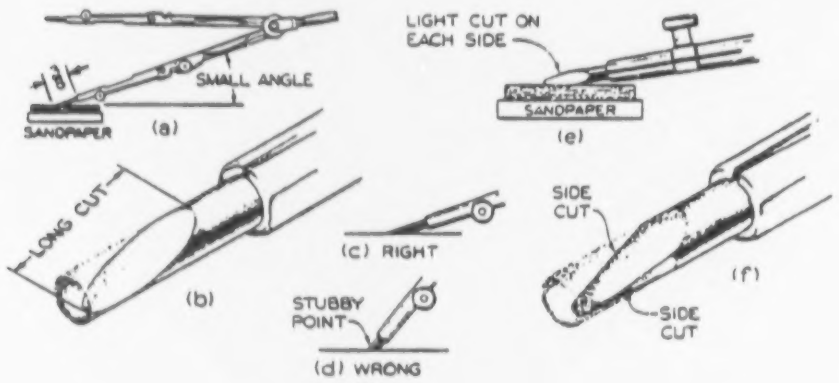


FIGURE 2

DIVIDE A CIRCLE INTO 24 PARTS OF 15° BY USING THE 30°/60° AND 45° TRIANGLE

Problem:

Directions: Divide a circle into 24 parts of 15° using only standard triangles and a parallel bar following the procedure demonstrated in Figure 1.

Procedure:

A. Use the established center point and center lines as a reference point from which two standard triangles can be used to find the first 15° angle (Figure 1).

B. Use one triangle to find the 30° angle next to the first 15° angle.

C. Use one triangle to find the 45° angle next to the first 30° angle.

D. Use one triangle to find the 60° angle next to the first 45° angle.

E. Use two triangles to find the 75° angle next to the 60° angle.

F. Use one triangle to find the 90° angle next to the first 75° angle.

G. Continue with triangles and a parallel bar until the circle has been divided into 24 parts and each angle has been correctly labeled.

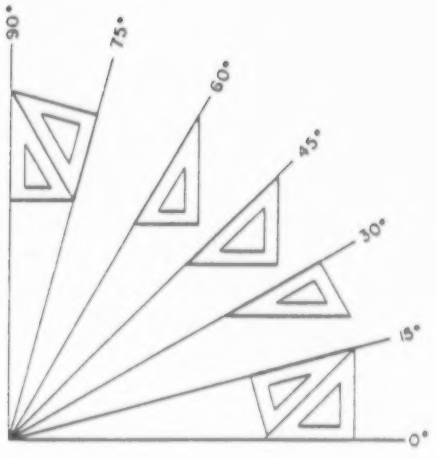
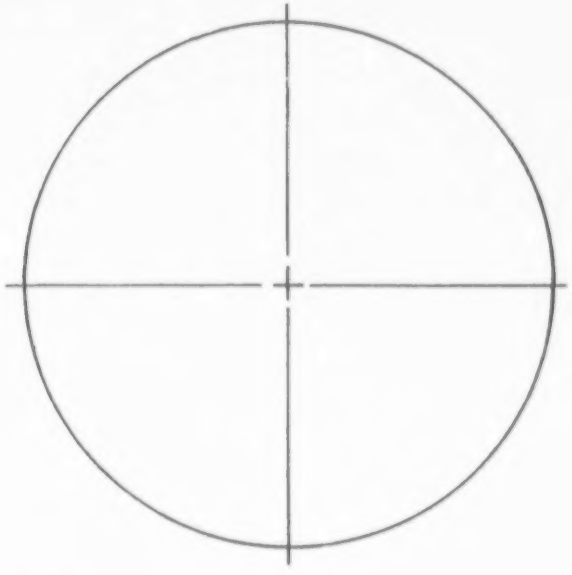


FIGURE 1



USE A COMPASS TO DRAW CIRCLES AND ARCS

Procedure:

NOTE: A compass is used to draw circles or arcs that are too large or different in size from a circle template.

A. Set the radius to be used (Figure 1-a).

(**CAUTION**: Do not place the compass directly on the scale because this practice could eventually damage the scale.)

B. After radius is determined, start the circle by holding the compass handle between the thumb and forefinger (Figure 1-b).

C. Set compass point at center, then use one hand to adjust the compass to the determined radius (Figure 1-c).

D. Complete the circle by rotating the compass in a clockwise direction.

E. Use the scale to check accuracy of the diameter before darkening lines.

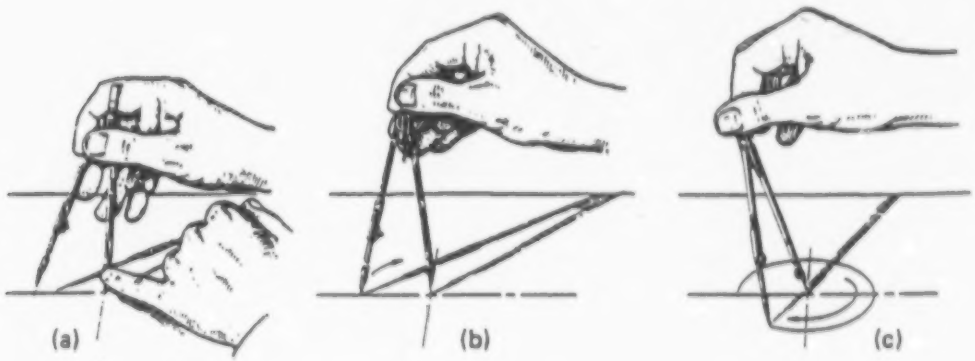


FIGURE 1

Problems:

A. Directions: Use "A" size drawing vellum with standard border and title block and divide the working space into two equal parts. Construct a 3 1/2" square centered on the left side of the working space and construct a figure like the one shown in Figure 2 in that space. Draw 1 3/4" radius arcs at A, B, C, and D, and construct small arcs so that they intersect as shown in Figure 2. Complete the problem by adding center lines.

NOTE: Omit radius lines A, B, C, and D from finished drawing.

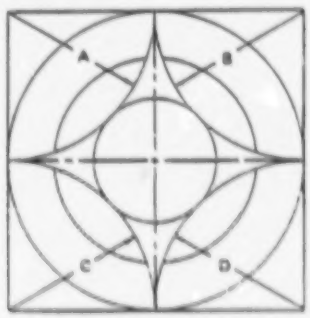


FIGURE 2

B. Directions: Construct a 3 1/2" square centered on the right side of the vellum used for Problem A and construct a figure like the one shown in Figure 3 in that space. Construct a 3" circle from center point, and then construct four 1 3/4" radius arcs using corners or squares as center points. Draw an inner circle so that it intersects as shown in Figure 3, and complete the problem by adding center lines.

NOTE: Omit radius lines A, B, C, and D from finished drawings.

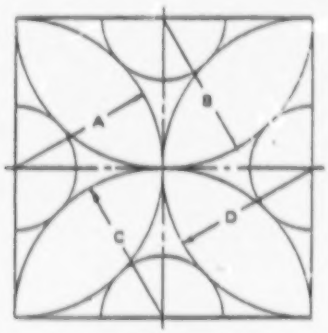


FIGURE 3

USE A DIVIDER

Procedure:

NOTE: A divider is used to transfer a dimension from one point to another or to subdivide a line into a given number of equal parts.

A. Divide a line into a given number of equal parts.

B. Set one point of the divider at one end of the line and use one hand to adjust the divider to approximately 1/3 the distance of the line (Figure 1-a).

NOTE: Distance will change depending upon number of divisions.

C. Swing the divider clockwise to the second point on the line (Figure 1-b).

D. Swing the divider counterclockwise to the third point on the line (Figure 1-c).

NOTE: If spacing is too short or long, lengthen or shorten the divider spacing slightly and try again; this is a trial and error method, but a useful method to practice.

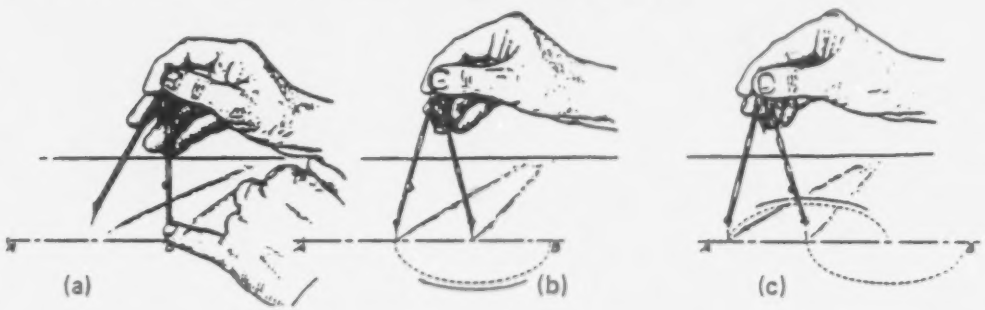


FIGURE 1

Problem:

Directions: Use "A" size vellum with standard border and title block and construct a 4" square in the center of the working space. Using Figure 2 as an example, divide lines A-D and B-C into seven equal parts locating the corners of the squares. Construct the squares and complete the figure by adding center lines.

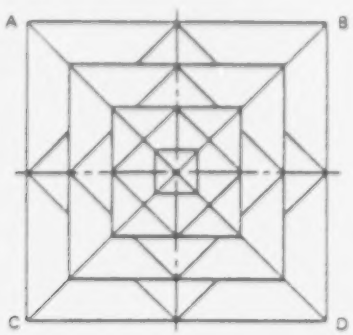


FIGURE 2

MEASURE ANGLES WITH A PROTRACTOR

Procedure:

A. Place the base line or 180° line of the protractor along one leg of angle to be measured with vertex of angle at marked center point of protractor (Figure 1).

B. Starting at zero, read up the side of the protractor right or left depending on the angle being measured.

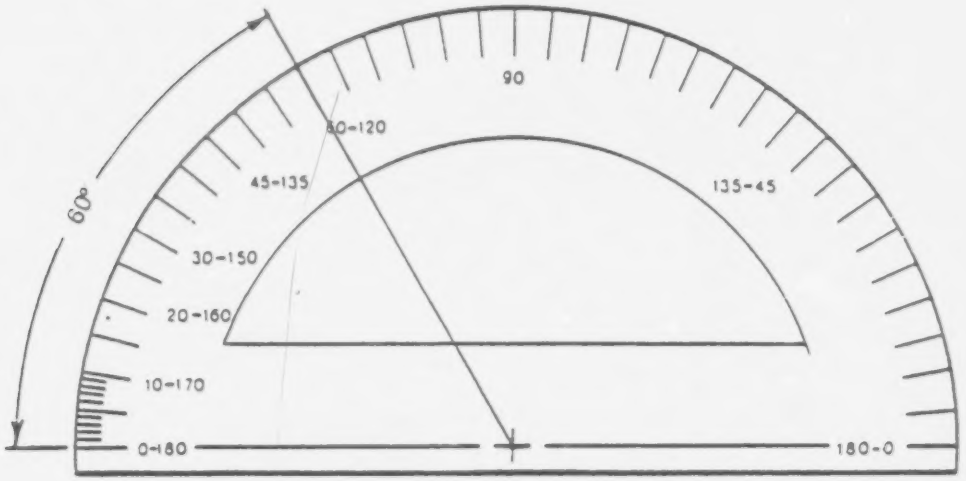
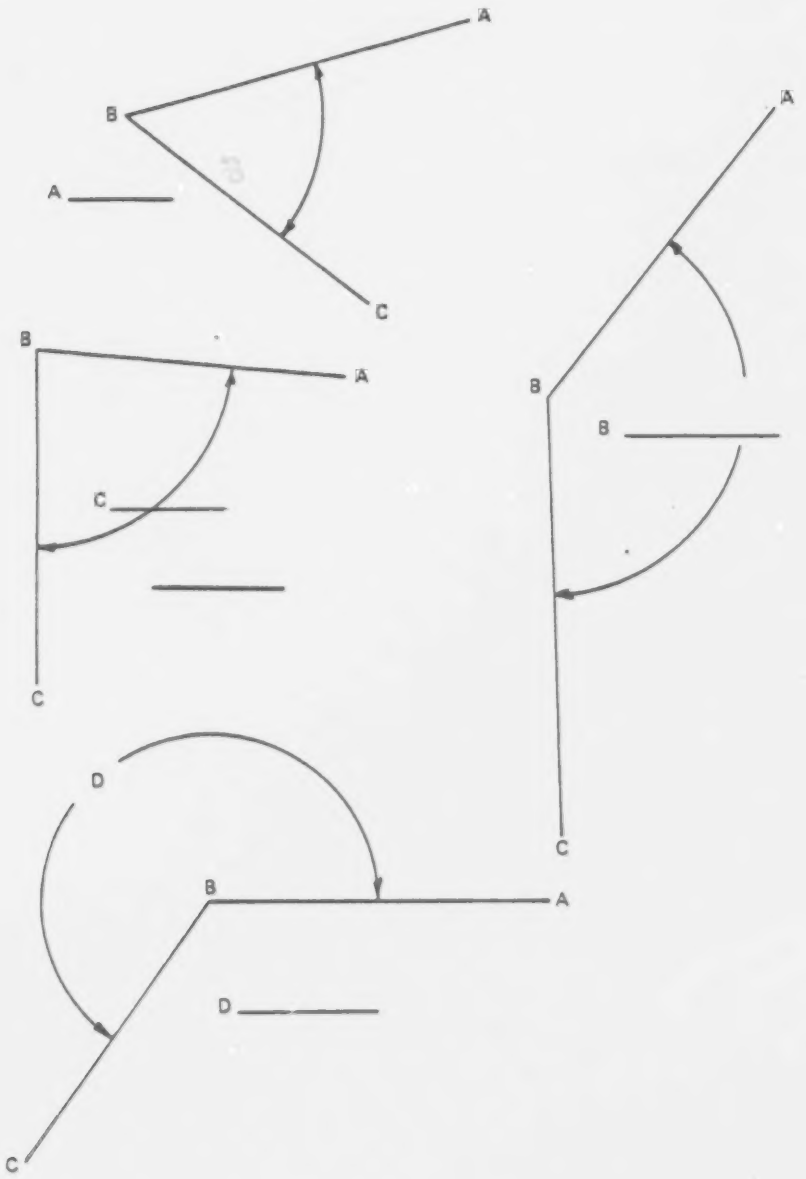


FIGURE 1

Problem:

Directions: Measure and record the angles shown in the blanks provided.



USE AN IRREGULAR CURVE TO CONSTRUCT A CURVED LINE

Procedure:

NOTE: The irregular curve is used to construct noncircular arcs.

A. Move the curve around to connect three or more given points.

B. Connect these points.

C. Move curve to new position using at least two points previously given.

D. Extend line to join new points (Figure 1).

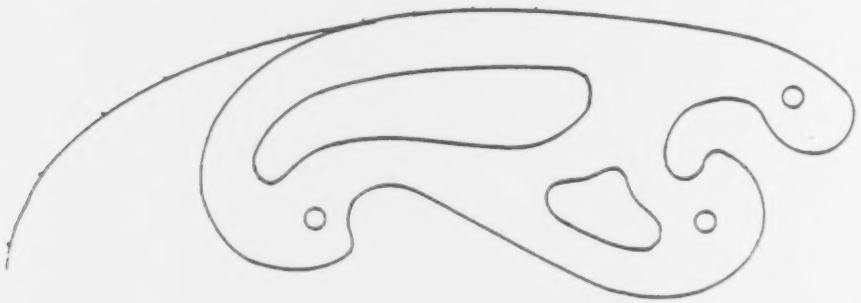
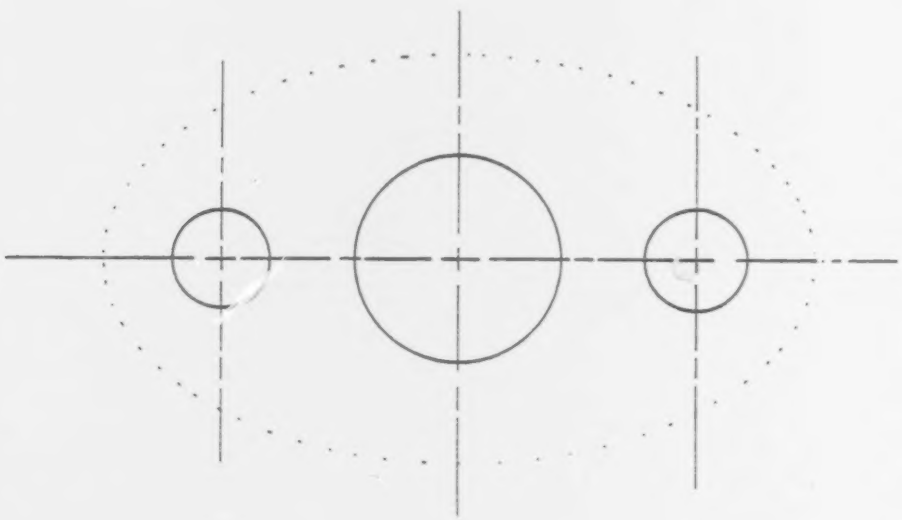


FIGURE 1

Problem:

Directions: Complete the following figure using irregular curve.

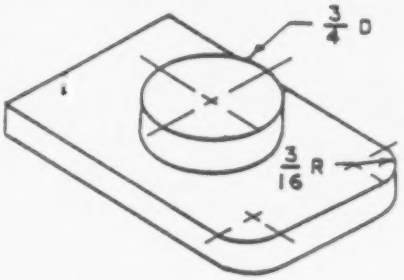


CONSTRUCT CIRCLES AND ARCS USING A TEMPLATE

Premise: Using circle templates in constructing small circles and arcs will save time. The templates have four alignment marks that will coincide with the center lines. The template hole openings will allow for width of lead. A 3/4" hole will actually measure about 13/16". Make sure pencil is perpendicular with template. Use the procedure in the following example for circles and arcs.

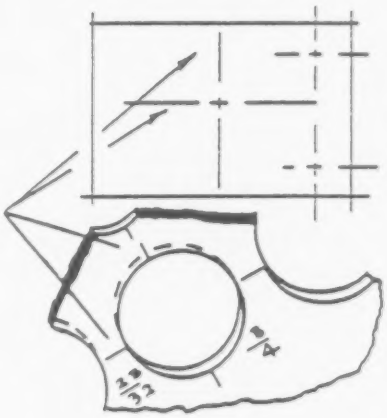
Example:

1. Block in object with light construction lines.



2. Locate and construct light center lines for circles and arcs.

3. Select correct hole diameter on circle template.



4. Align marks on template with center lines, and construct the required circle lightly.

   NOTE: Alignment marks on some templates are not printed accurately.

5. Select correct hole on circle template for arc radius.

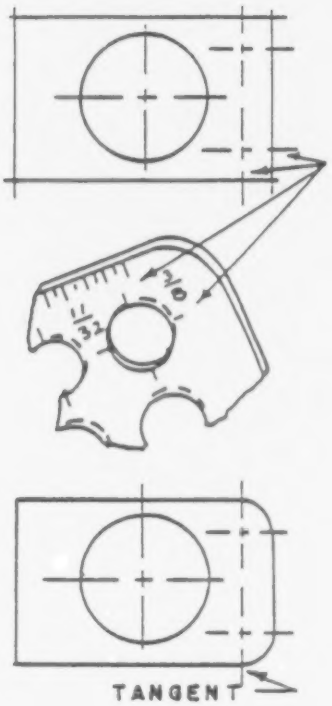
   NOTE: Radius is equal to 1/2 diameter.

6. Align marks on template with center lines, and construct the required arc lightly.

7. Erase all construction lines not needed.

8. Darken in circles and arcs first, then straight lines.

   NOTE: Arcs tangent to straight lines should meet and align smoothly.



CONSTRUCT A DRAWING USING MECHANICAL PENCILS

I. **Tools and equipment:**

II. **Procedure:**

A. Draw the objects below.

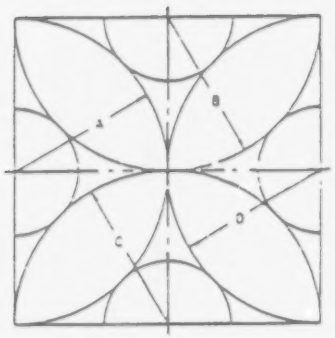


FIG. 1

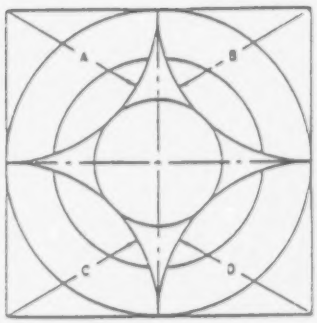


FIG. 2

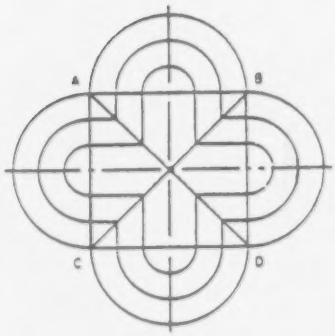


FIG. 3

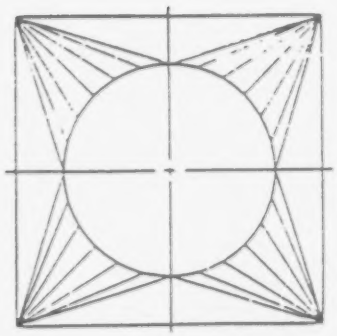


FIG. 4

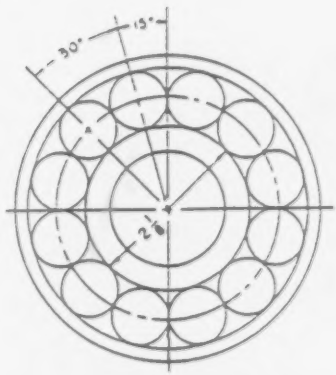


FIG. 5

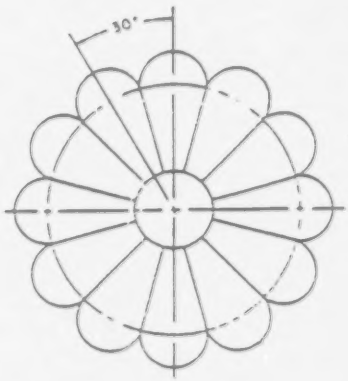


FIG 6

CONSTRUCT A DRAWING USING TECHNICAL INK PENS

I. **Tools and equipment:**

II. **Procedure:**

A. Draw the objects below.

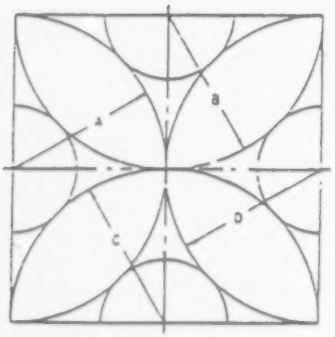


FIG. 1

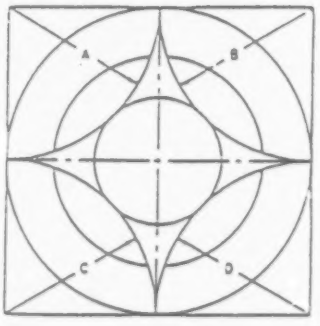


FIG. 2

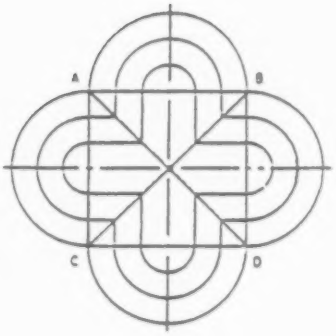


FIG. 3

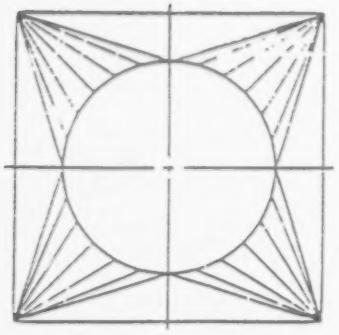


FIG. 4

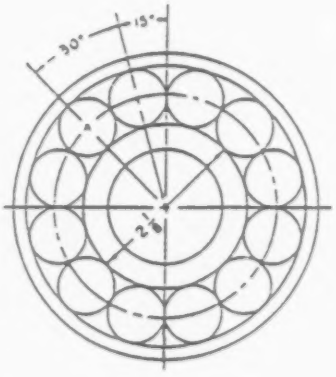


FIG. 5

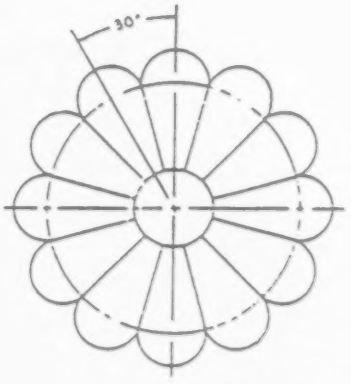


FIG 6

CONSTRUCT A DRAWING USING REPRODUCTION TECHNIQUES AND MATERIALS

I. **Tools and equipment:**

II. **Procedure:**

A. Edit a sepia drawing, sticky-back appliques or transfers.

MODULE: DRAFTING FUNDAMENTALS

UNIT III: TOOLS AND LINES

UNIT TEST

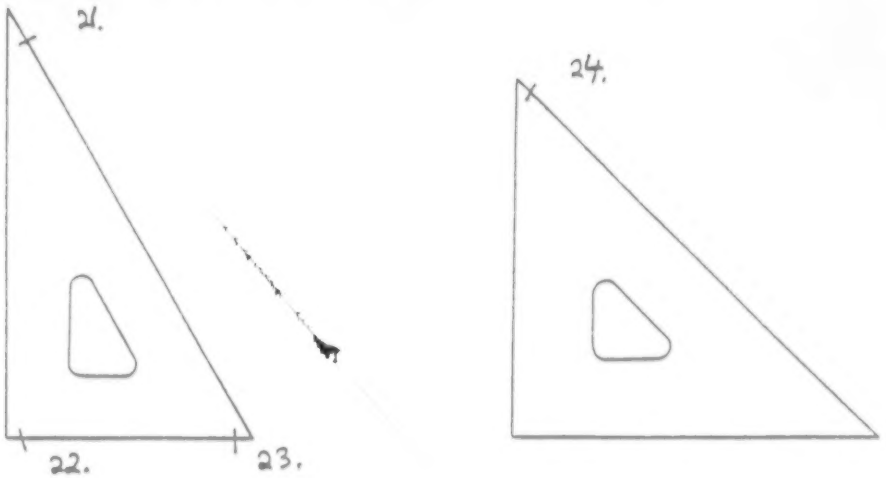
Match the terms on the right with their correct definitions on the left.

____	1.	A metal plate with various slots and openings used to protect linework when a portion of the drawing is to be erased	a.	Triangle
____	2.	An instrument used to measure the length of a line	b.	Lettering guide
____	3.	A covering used to protect drawings and equipment when not in use	c.	Compass
____	4.	An instrument used to lay out guidelines for lettering	d.	Divider
____	5.	A sharpening device for mechanical pencil leads	e.	Erasing shield
____	6.	An instrument used to measure angles	ab.	Lead pointer
____	7.	An instrument used to transfer dimensions	ac.	Mechanical lead holder
____	8.	An instrument used to draw circles and arcs	ad.	Scale
____	9.	An instrument consisting of a thin, flat right-angled piece of plastic or metal with acute angles of 45°, or 30° and 60°	ae.	Dust cover
____	10.	A metal holder in which leads of various hardness can be inserted	bc.	Protractor

Match the terms on the right with their correct definitions on the left.

____	11.	An instrument used to lay out any noncircular curve	a. Plastic lead
____	12.	A thin, flat, plastic tool with various size openings of different shapes used to expedite the drawing of standard features	b. Irregular curve c. Template
____	13.	A tool used to brush loose graphite and eraser dust from a drawing	d. Cleaning pad e. Lead cleaner
____	14.	A loosely woven bag of ground art gum eraser used to remove loose graphite from a drawing	ab. Eraser
____	15.	A device used to remove pencil lines and graphite smudges from a drawing	ac. Lead ad. Dusting brush
____	16.	A styrofoam pad or tissue paper used to remove loose graphite from a pencil lead after it has been sharpened	ae. Ink
____	17.	A specially prepared tape does not harm surface of table or drawing media	bc. Drafting tape
____	18.	Composed mainly of carbon in colloidal suspension and gum. The fine particles of carbon give the deep, dark, black, appearance to the ink, and the gum makes it quick to dry and waterproof	
____	19.	Made of graphite with kaoline added in varying amounts in order to make the eighteen grades from the hardest (9H) to the softest (7B)	
____	20.	Composed of varying amounts of graphite with plastic	

Identify the angles found on the two standard triangles.



___ 21. a. 22 1/2°

___ 22. b. 30°

___ 23. c. 45°

___ 24. d. 60°

e. 90°

Identify true and false statements concerning rules for maintenance and care of drafting tools and equipment by marking an "a" before true statements and a "b" before false statements.

___ 25. Do not bend templates sharply

___ 26. Template and scales can be used as a straight edge for cutting

___ 27. Keep all instruments clean and dry

___ 28. A circle template can be used as an eraser shield

___ 29. Do not hit scales and triangles on edges

___ 30. Compasses and dividers should not be over extended

___ 31. Clean plastic tools with soap and water only

Match the types of lead on the right with the devices used to sharpen them.

____	32.	File	a.	Compass leads
____	33.	Sandpaper pad	b.	Wood-cased drawing pencil leads
____	34.	Drafter's pencil sharpener	c.	Mechanical lead-holder leads
____	35.	Metal-cutter lead pointer		
____	36.	Sandpaper-cone lead pointer		

Distinguish between the advantages of ink, lead, and plastic lead by placing an "a" next to the advantages of ink, a "b" next to the advantages of lead, and a "c" next to advantages of plastic lead.

____ 37. Quick and easy

____ 38. Does not smudge

____ 39. Does not smudge as easily as lead

____ 40. Lines are completely readable through microfilm reduction and blowback

____ 41. Reproduces a clean, dense line

____ 42. Revisions of original drawings can be made easily with no "ghost" or damage to drawing surface

Match each reproduction on the right with its correct medium on the left.

____	43.	Lead	a.	Acceptable
____	44.	Plastic lead	b.	Good
____	45.	Ink	c.	Excellent

46. **Describe nonreproducible lead:** _____

_____

_____

47. **Name three types of drafting pencils.**

a. _____

b. _____

c. _____

48. **List the sizes of thin-lead mechanical pencils.**

a. _____

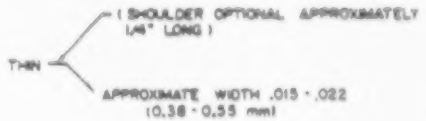
b. _____

c. _____

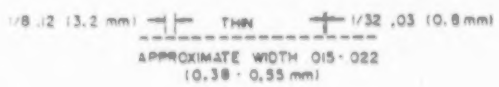
d. _____

49. **Identify the basic types of lines.**

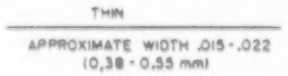
a. _____



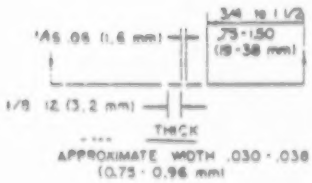
b. _____



c. _____



d. _____



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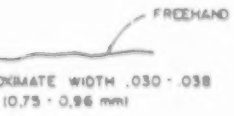

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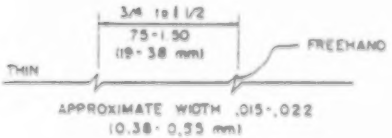

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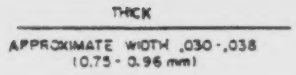
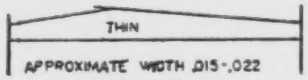
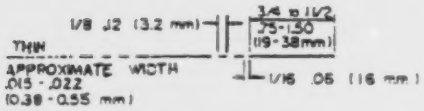

THICK
APPROXIMATE WIDTH .030 - .038
(0.75 - 0.96 mm)

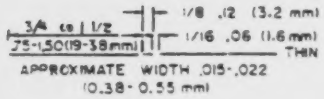
h. _____


THIN
APPROXIMATE WIDTH .015 - .022
(0.38 - 0.55 mm)

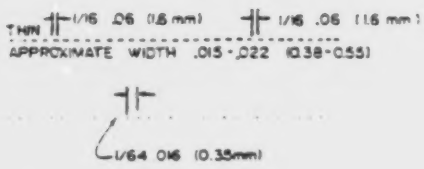
i. _____


1/8 .12 (3.2 mm)
3/4 to 1 1/2
.75 - 1.50
(19 - 38 mm)
THIN
APPROXIMATE WIDTH
.015 - .022
(0.38 - 0.55 mm)
1/16 .06 (1.6 mm)

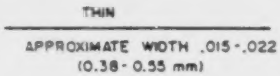
j. _____


1/8 .12 (3.2 mm)
3/4 to 1 1/2
.75 - 1.50 (19 - 38 mm)
1/16 .06 (1.6 mm)
THIN
APPROXIMATE WIDTH .015 - .022
(0.38 - 0.55 mm)

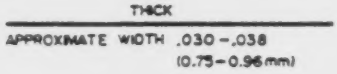
k. _____


THIN
1/16 .06 (1.6 mm)
1/16 .06 (1.6 mm)
APPROXIMATE WIDTH .015 - .022 (0.38 - 0.55)
1/64 .016 (0.35mm)

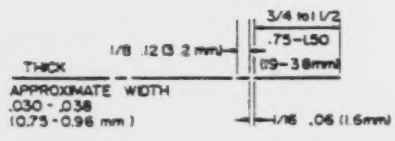
l. _____


THIN
APPROXIMATE WIDTH .015 - .022
(0.38 - 0.55 mm)

m. _____


THICK
APPROXIMATE WIDTH .030 - .038
(0.75 - 0.96 mm)

n. _____


1/8 .12 (3.2 mm)
3/4 to 1 1/2
.75 - 1.50
(19 - 38 mm)
THICK
APPROXIMATE WIDTH
.030 - .038
(0.75 - 0.96 mm)
1/16 .06 (1.6 mm)

ANSWERS TO UNIT III TEST

1. e (B1)
2. ad (B1)
3. ae (B1)
4. b (B1)
5. ab (B1)
6. bc (B1)
7. d (B1)
8. c (B1)
9. a (B1)
10. ac (B1)
11. b (B1)
12. c (B1)
13. ad (B1)
14. d (B1)
15. ab (B1)
16. e (B1)
17. bc (B1)
18. ae (B1)
19. ac (B1)
20. a (B1)
21. b (B1)
22. e (B1)
23. d (B1)
24. c (B1)
25. a (B2)
26. b (B2)
27. a (B2)
28. b (B2)
29. a (B2)
30. b (B2)
31. a (B2)
32. a (B2)
33. a (B2)
34. b (B2)
35. c (B2)
36. c (B2)
37. b (B1)
38. a (B1)
39. c (B1)
40. a (B1)
41. a (B1)
42. a (B1)
43. a (B1)
44. b (B1)
45. c (B1)
46. A lead that will not reproduce by standard reproduction machines. It is used for layout work, only. (B1)
47. All of the following in any order: (B1)
    a. Wood-cased drawing pencil
    b. Mechanical pencil
    c. Thin-lead mechanical pencil
48. All of the following in any order: (B1)
    a. .03 mm
    b. .05 mm
    c. .07 mm
    d. .09 mm

49. (C-6)

a. Leader line
b. Hidden line
c. Section line
d. Cutting plane line
e. Short-break line
f. Long-break line
g. Visible line
h. Extension line
i. Phantom line
j. Center line
k. Stitch line
l. Dimension line
m. Border line
n. Chain line

MODULE: DRAFTING FUNDAMENTALS

UNIT IV: ARCHITECT'S SCALE USAGE

UNIT OBJECTIVE

After completion of this unit, the student should be able to describe an architect's scale, list the seven scale ratios found on an architect's scale, and read an architect's scale at various ratios. The student should also be able to measure lines accurately using various scale ratios. This knowledge will be evidenced by correctly performing the procedures outlined on the assignment sheets and by scoring _____ percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

4.1 Match terms related to architect's scale with their correct definitions.

4.2 Describe an architect's scale.

4.3 State the purpose for using a scale.

4.4 Identify five basic shapes of scales.

4.5 List seven scale ratios found on an architect's scale.

4.6 Select rules for correct scale usage.

4.7 Interpret 1/16, 1/8, and 1/4 graduations on a full size scale.

4.8 Calculate and locate 1/32" graduations on a full size scale.

4.9 Read the architect's scale at full scale ratio 12" = 1'-0"

4.10 Read the architect's scale at the scale ratio 6" = 1'-0"

4.11 Read the architect's scale at the scale ratio 3" = 1'-0".

4.12 Read the architect's scale at the scale ratio 1 1/2" = 1'0".

4.13 Read the architect's scale at the scale ratio 1/4" = 1'-0".

4.14 Demonstrate the ability to:

a. Interpret 1/16 and 1/32 graduations on a full size scale.

b. Read the architect's scale at full scale ratio 12" = 1'-0".

c. Read the architect's scale at the scale ratio 6" = 1'-0".

d. Read the architect's scale at the scale ratio 3" = 1'-0".

e. Read the architect's scale at the/ scale ratio 1 1/2" = 1'-0".

f. Measure lines accurately with various scale ratios on an architect's scale.

MODULE: DRAFTING FUNDAMENTALS

UNIT IV: ARCHITECT'S SCALE USAGE

CONTENTS OF THIS UNIT

A. Objective Sheet

B. References

C. Notes to the instructor

D. Lesson plans

1. Lesson 1: USING THE ARCHITECT'S SCALE

   a. Information outline

   b. Transparency masters

      TM 4.1: Architect's Scale
      TM 4.2: Graduations on a Scale
      TM 4.3: Measurements at Scale of 12" = 1'-0" (Full-size)
      TM 4.4: Measurements at Scale of 6" = 1'-0" (Half-size)
      TM 4.5: Measurements at Scale of 3" = 1'-0" (1/4 size)
      TM 4.6: Measurements at Scale of 1 1/2 = 1'-0" (1/8 size)
      TM 4.7: Measurements at Scale of 1/4" = 1'-0" (1/48 size)

   c. Assignment Sheets

      AS 4.1: Interpret 1/16 and 1/32 Graduations on a Full Size Metal Rule
      AS 4.2: Read the Architect's Scale at Full Scale Ratio 12" = 1'-0"
      AS 4.3: Read the Architect's Scale at the Scale Ratio 6" = 1'-0"
      AS 4.4: Read the Architect's Scale at the Scale Ratio 3" = 1'-0"
      AS 4.5: Read the Architect's Scale at the Scale Ratio 1 1/2" = 1'-0"
      AS 4.6: Measure Lines Accurately with Various Scale Ratios on an Architect's Scale

   d. Answers to assignment sheets

E. Unit test

F. Answers to unit test

REFERENCES

1. Brown, Walter C. Drafting for Industry. South Holland, Ill. 60473: The Goodheart-Willcox Company, Inc., 1974.

2. Davis, Ronald, Bill Hill and Bruce Yancey. Basic Drafting: Book One. Stillwater, Okla. 74074: Mid-America Vocational Curriculum Consortium, Inc., 1981.

3. Dygdon, John Thomas and Spencer, Henry Cecil. Basic Technical Drawing. New York, 10022: Macmillan Publishing Co., Inc., 1968.

4. Gerevas, Lawrence E. Drafting Technology Problems, 2nd ed. Indianapolis, Ind. 46268: Bobbs-Merrill Educational Publishing, 1981.

5. Giesecke, Frederick E., et al. Technical Drawing. New York, 10022: Macmillan Publishing Co., Inc., 1980.

6. Jensen, Cecil and Helsel, Jay. Engineering Drawing and Design. New York: Gregg Division/McGraw-Hill Book Company, 1979.

7. Spence, William P. Drafting Technology and Practice, Revised ed. Pittsburgh, Kan. 66762: Bennett & McKnight Publishing Company, 1980.

8. Wallach, Paul Ross. Drafting Problems, 2nd ed. Mission Hills, Calif. 91345: Glencoe Publishing Company, 1988.

NOTES TO THE INSTRUCTOR

A. Suggested approaches to teaching this unit

1. Develop a display of all types of measuring rules, tapes, scales, and related items used in various machine and building trades. Include all five types of scales used in a drafting room. Discuss this display in depth with students.

2. Explain why scaling should not be completed on blueprint copies.

3. Use unit test as a pre-test to determine prior knowledge of the architect's scale usage.

MODULE: DRAFTING FUNDAMENTALS

UNIT IV: ARCHITECT'S SCALE USAGE

LESSON 1: USING THE ARCHITECT'S SCALE

I. Terms and definitions

A. **Actual size**--an object's dimensions, the size it actually is in completed form

B. **Architecture**--dealing with the design and drawing of public and private buildings

C. **Draw to scale**--drawing an object at a set proportion such as half its actual size, one-fourth its actual size, or double its actual size

D. **Fraction**--a part of a whole, such as 1/2 or 1/4

E. **Full-divided scale**--a scale with the basic units subdivided throughout the length of the scale

F. **Graduations**--the subdivisions in a scale unit, all of which are equal in size and length

G. **NTS**--abbreviation meaning "not-to-scale"

H. **Open-divided scale**--a scale with only the end unit subdivided into fractional parts

I. **Scale**--an instrument used as a standard of reference when drawing an object to a proportional size

J. **Scale ratio**--a relationship between dimension values used to reduce or enlarge the size of an object so that it can be drawn to proportion

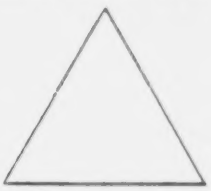
II. Description of architect's scale--scale used primarily for drawings of buildings, piping systems, and other large structures which must be drawn to a reduced scale to fit on a standard size sheet; it has one full-size scale and ten reduced-size scales (TM 4.1)

NOTE: In all of the reduced scales, the major divisions represent feet, and their subdivisions represent inches and fractions thereof--thus 3/4" scale means 3/4 inch = 1 foot, **NOT** 3/4 inch = 1 inch

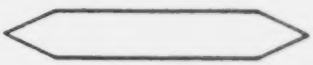
III. Purpose of using a scale to draw--enables objects which are too large or too small to be drawn to actual size, or be drawn with a standard point of reference controlling the relative size of each art

IV. Basic shapes of scales

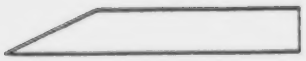
A. Triangular



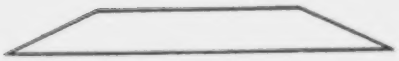
B. Four-bevel



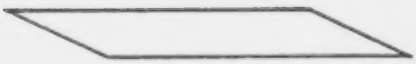
C. One-bevel



D. Two-bevel



E. Opposite-bevel



V. Scale ratios found on architect's scale

A. 12" = 1'- 0"--Full size

B. 6" = 1'- 0"--Half size

C. 3" = 1'- 0"--1/4 size

D. 1 1/2" = 1'- 0--1/8 size

E. 1" = 1'- 0"--1/12 size

F. 3/4" = 1'- 0"--1/16 size

G. 1/2" = 1'- 0"--1/24 size

H. 3/8" = 1'- 0"--1/32 size

I. 1/4" = 1'- 0"--1/48 size

J. 3/16" = 1'- 0"--1/64 size

K. 1/8" = 1'- 0"--1/96 size

L. 3/32" = 1'- 0"--1/128 size

VI. Rules for correct scale usage

A. Select proper scale ratio

B. Scale should lay flat on the surface being measured

C. Scale should be parallel with or on line being measured

D. Do not stick compass or divider points into scale

E. Edge of the scale should be protected to prevent damage to its graduation marks

F. A short dash should be made rather than a point to mark a distance

G. If a series of measurements are to be made on full size scale, do not move scale for each measurement

NOTE: Set off measurements with scale in one position

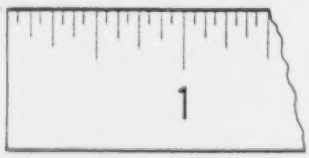
H. Make sure that the line of sight does not create an optical illusion

NOTE: This could result in an incorrect measurement

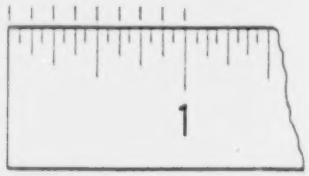
VII. How to interpret 1/16", 1/8", 1/4" and 1/2" graduations on a full size scale (TM 4.2)

A. Full scale (12" represents 1'- 0")

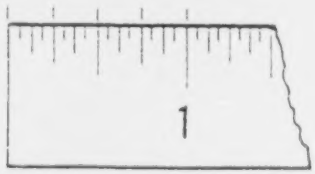
1. Sixteen one-sixteenths (16/16) = one inch (1")



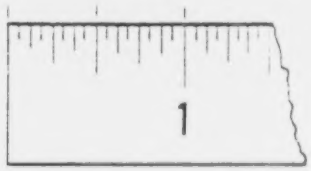
2. Eight one-eighths 8/8 = one inch (1"); two one-sixteenths (2/16) = one-eighth inch (1/8")



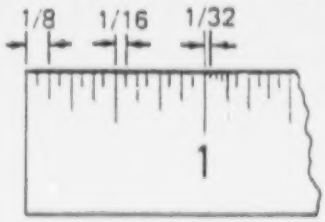
3. Four one-fourths (4/4) = one inch (1"); four one-sixteenths (4/16) = one-fourth inch (1/4")



4. Two one-halves (2/2) = one inch (1"); eight one-sixteenths (8/16) = one-half inch (1/2")



5. For 1/32" increments there are two 1/32" in one 1/16" and two 1/16" in one 1/8"



B. Dimensions are read in this order

1. Feet marked thus (')

2. Inches marked thus (")

3. Fractions of an inch (1/4, 1/2, etc)

NOTE: When measuring less than 12 inches, use the symbol "---over 12 inches should be symbolized in feet ' or feet plus inches as in 1'-3"

VIII. How to calculate and locate 1/32" graduations on a full size scale

A. For 1/32" increments there are two 1/32" in one 1/16"

B. Subtract 1/32" from the reading being worked with to find the nearest 1/16 unit under the reading

C. Add 1/32" to the reading being worked with to find the nearest 1/16 unit over the reading

D. Find the lower and higher 1/16 units on the scale and approximate the center between the two

E. Mark this approximate center by making a short dash with a sharp light lead and observe reading

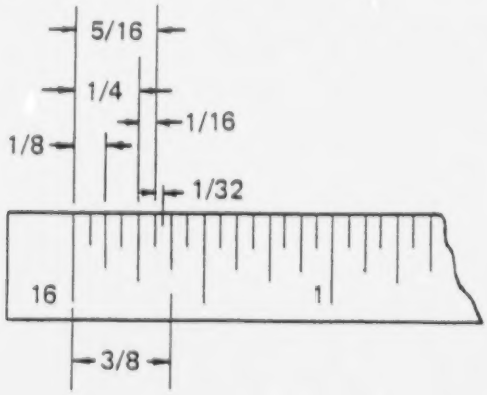
Example: The reading wanted is 11/32"

1. Subtract 1/32" which gives 10/32 or 5/16"

2. Add 1/32" which gives 12/32 or 3/8"

3. Locate 5/16 and 3/8 and approximate center

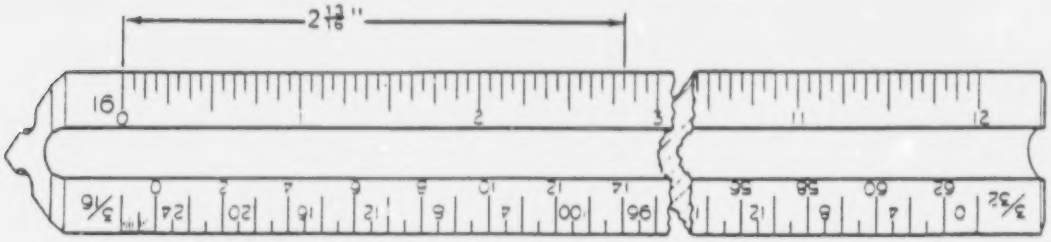
4. Mark approximate 11/32" point



IX. Read the architect's scale at full scale ratio 12" = 1'- 0" (TM 4.3)

NOTE: Measurement is made by reading directly from full size scale in inches and fractions

Example: If the reading wanted is 2 13/16", start at "0" and determine how many full inches are between 0 and the point being measured; there are 2. Next, determine how many 1/16" units are between the last full inch and the point being measured; there are 13 1/16" units and the measurement is 2 13/16"



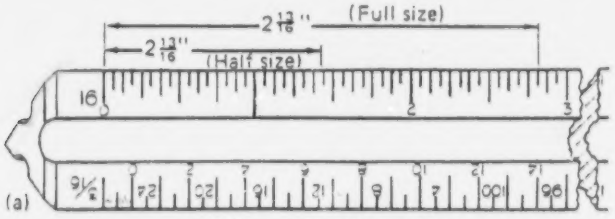
X. Read the architect's scale at the scale ratio 6" = 1'- 0" (TM 4.4)

A. When measuring a given line at half size, use the full-size scale, and multiply the full size dimension by 2

B. When laying out or drawing a line at half size, use the full-size scale, and divide the full size dimension by 2 to obtain line length

Example: The reading is 2 3/16" and the full size scale measures 1 13/32" so multiply 1 13/32" by 2 giving 2 13/16"; the measurement is 2 13/16" at half size because at half size, each 1/16" unit will represent 1/8"

NOTE: Study this information carefully, as it can be confusing



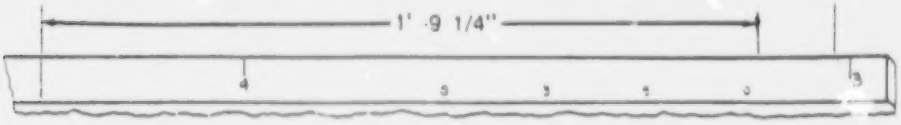
Full-Size and Half-Size Scale

XI. Read the architect's scale at the scale ratio 3" = 1'-0" (TM 4.5)

A. When measuring a given line, at 3" = 1'0", use the quarter size scale marked with a "3"

B. The subdivided unit to the right of zero represents one foot (12") compressed to actually 3" in length, and it is divided into inches, then half inches, quarter inches, and finally eighth inches

Example: If the reading is 1'-9 1/4", lay the scale so that the 3" = 1'- 0" scale lays parallel to the line being measured, then determine how many full feet to the left of zero the line extends (in this example it is 1" = 0"); set the 1'- 0" mark at the left end of the line being measured and refer to the right of the zero in the subdivided scale area for the inches and fractions (in this example it is 9 1/4") so the reading is 1'-9 1/4"



(One Fourth Size) 3" = 1'-0"

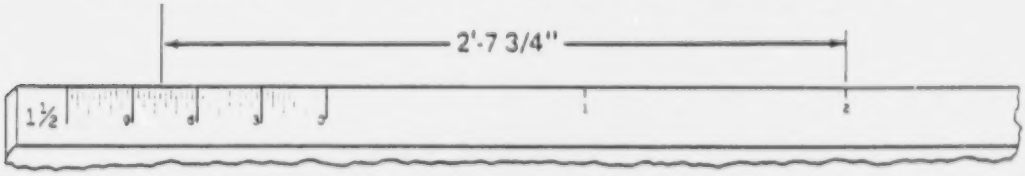
XII. Read the architect's scale at the scale ratio 1 1/2" = 1'- 0" (TM 4.6)

A. When measuring a given line, at 1 1/2" = 1'-0" use the 1/8 size scale marked with a "1 1/2"

B. The subdivided unit to the left of zero represents one foot (12") compressed to actually 1 1/2" in length, and is divided into inches, half inches, and quarter inches

C. Measure full feet to the right of the zero and measure anything less than 12" in the subdivided unit to the left of zero

Example: If the reading is 2'-7 3/4", lay the scale so that the 1 1/2" = 1'- 0" scale lays parallel to the line being measured; determine how many full feet to the right of zero the line extends (in this example it is 2'- 0") then set the 2'- 0" mark at the right end of the line being measured and refer to the left of the zero in the subdivided scale area for the inches and fractions (in this example it is 7 3/4") so the total length is 2'-7 3/4"



(One-Eighth Size) 1 1/2"=1'0"

XIII. Read the architect's scale at the scale ratio 1/4" = 1'- 0" (TM 4.7)

A. When measuring a given line at 1/4" = 1'- 0", use the 1/48 size scale marked with a 1/4"

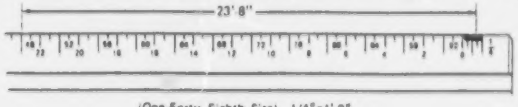
B. The subdivided portion to the right of zero represents one foot (12") compressed to actually 1/4" in length, and is divided into inches

C. Measure full feet to the left of zero and measure anything less than 12" in the subdivided unit to the right of zero

Example: If the reading is 23'- 8", lay the scale so that the 1/4" = 1'0" scale lays parallel to the line being measured; determine how many full feet to the left of zero the line extends (in this example it is 23'- 0")

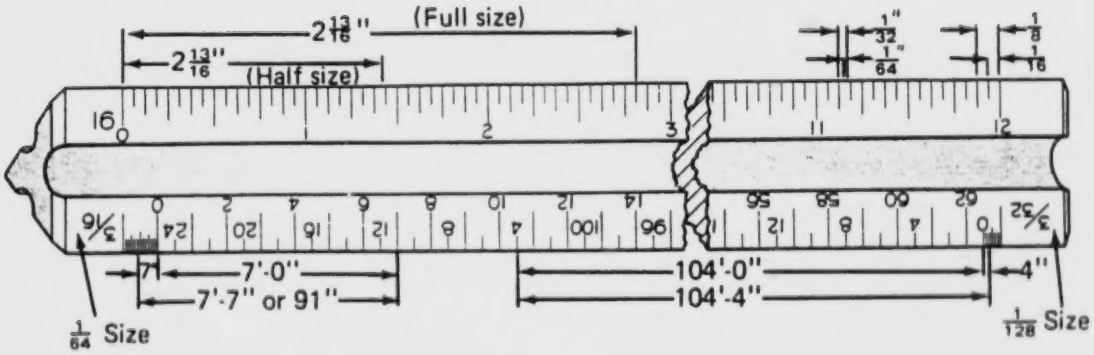
NOTE: Be sure you don't pick up the wrong numbers from the 1/8" = 1'- 0" scale that is in between the 1/4" = 1'- 0" numbers

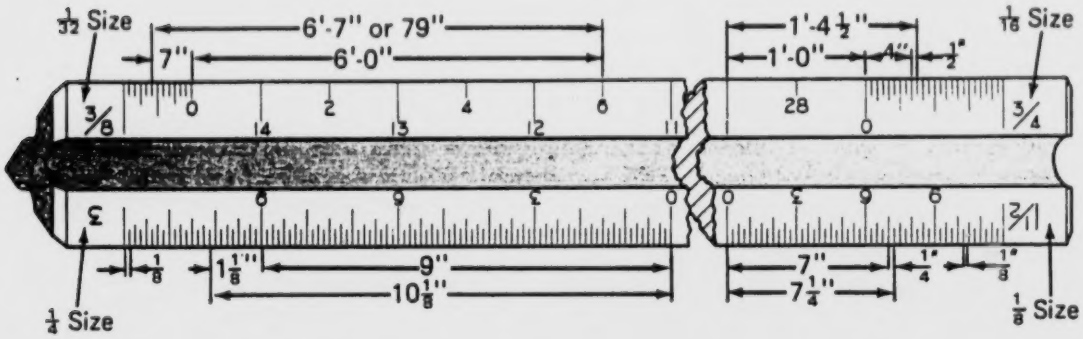
Set the 23'- 0" mark at the left end of the line being measured and refer to the right of the zero in the subdivided scale area for the inches and fractions (in this example it is 8")

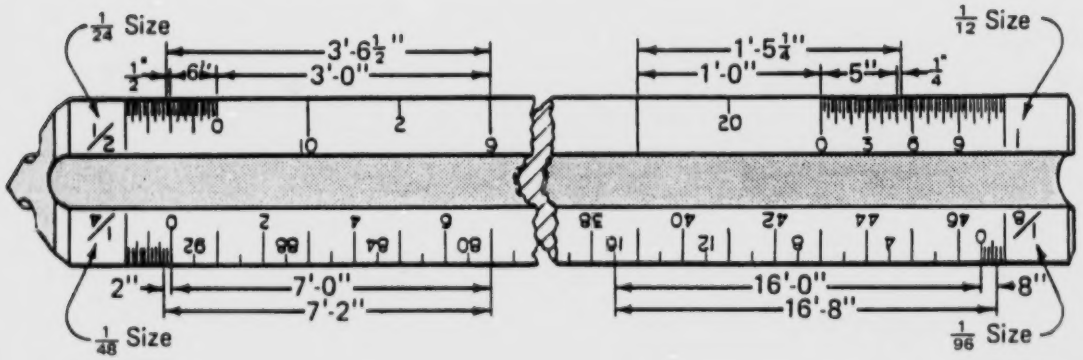


(One-Forty Eighth Size) 1/4"=1'-0"

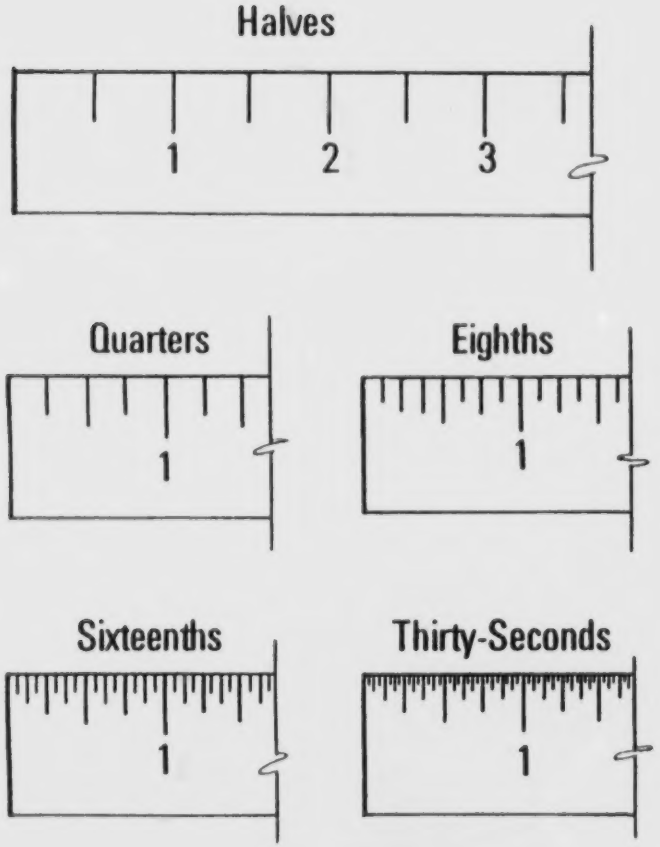
ARCHITECT'S SCALE

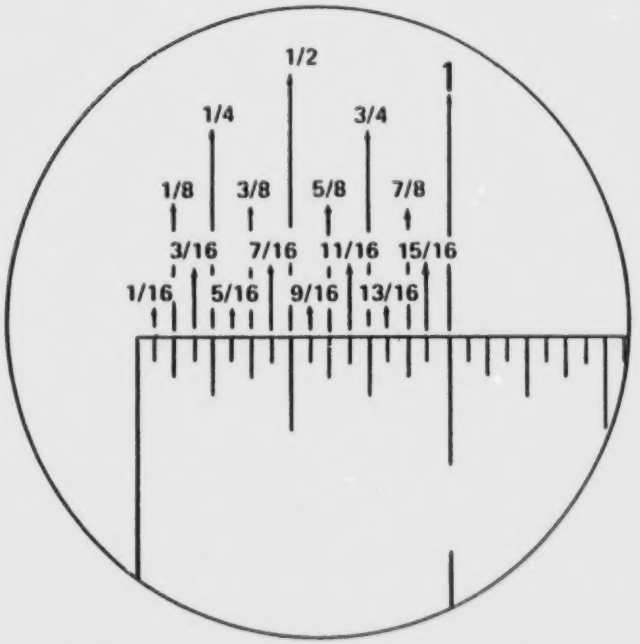






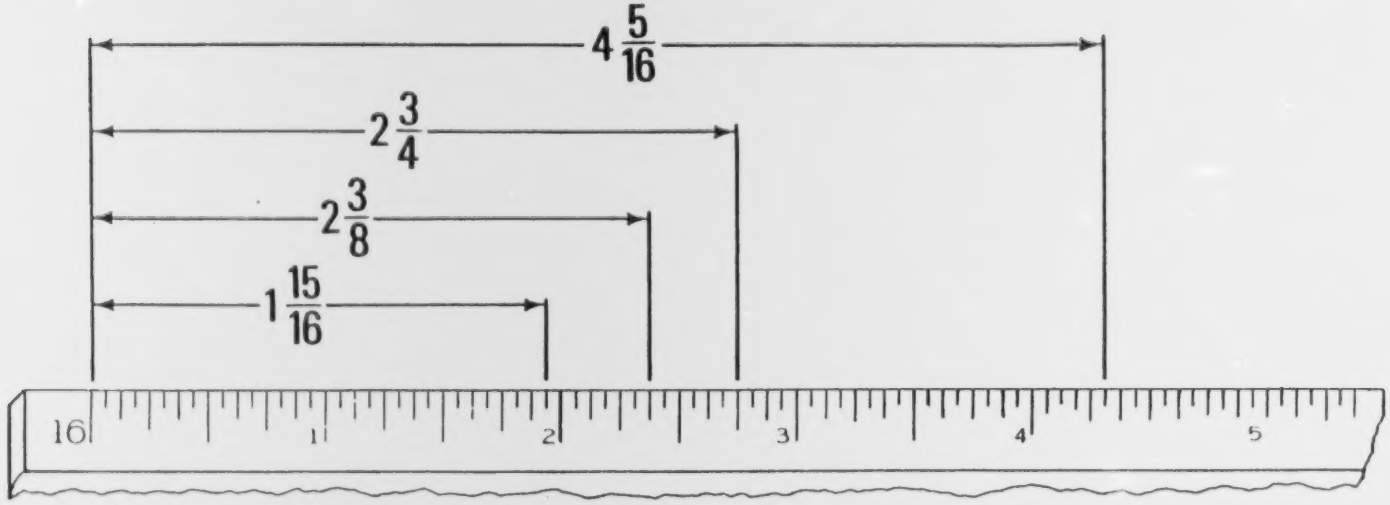
GRADUATIONS ON A SCALE





Graduations Applied to a Rule

MEASUREMENTS AT SCALE OF 12" = 1' - 0" (FULL SIZE)



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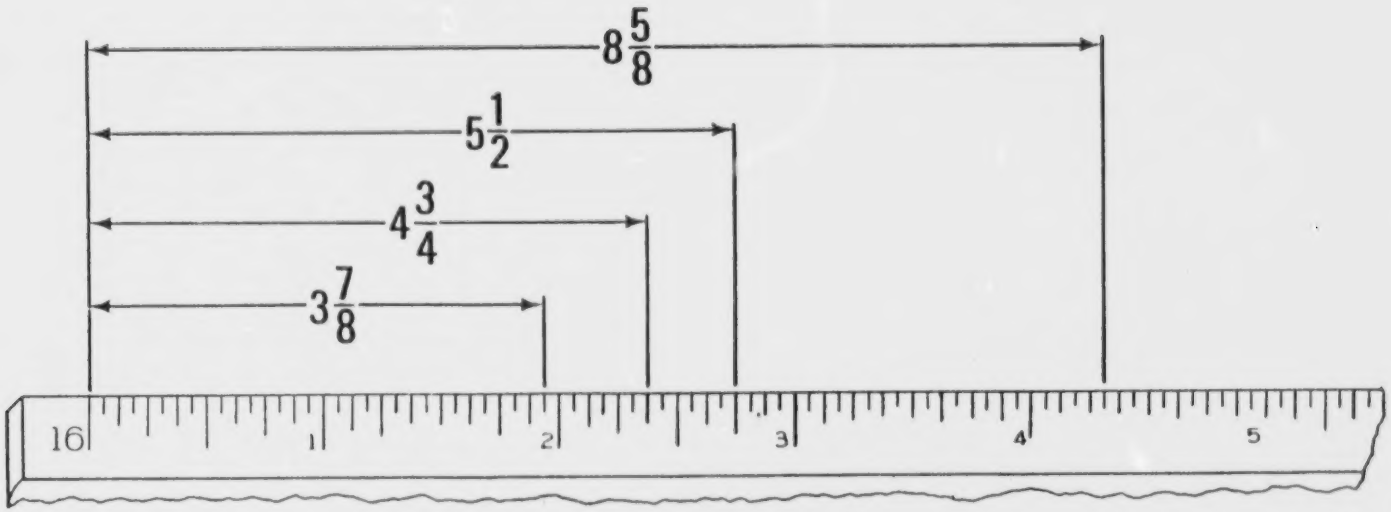
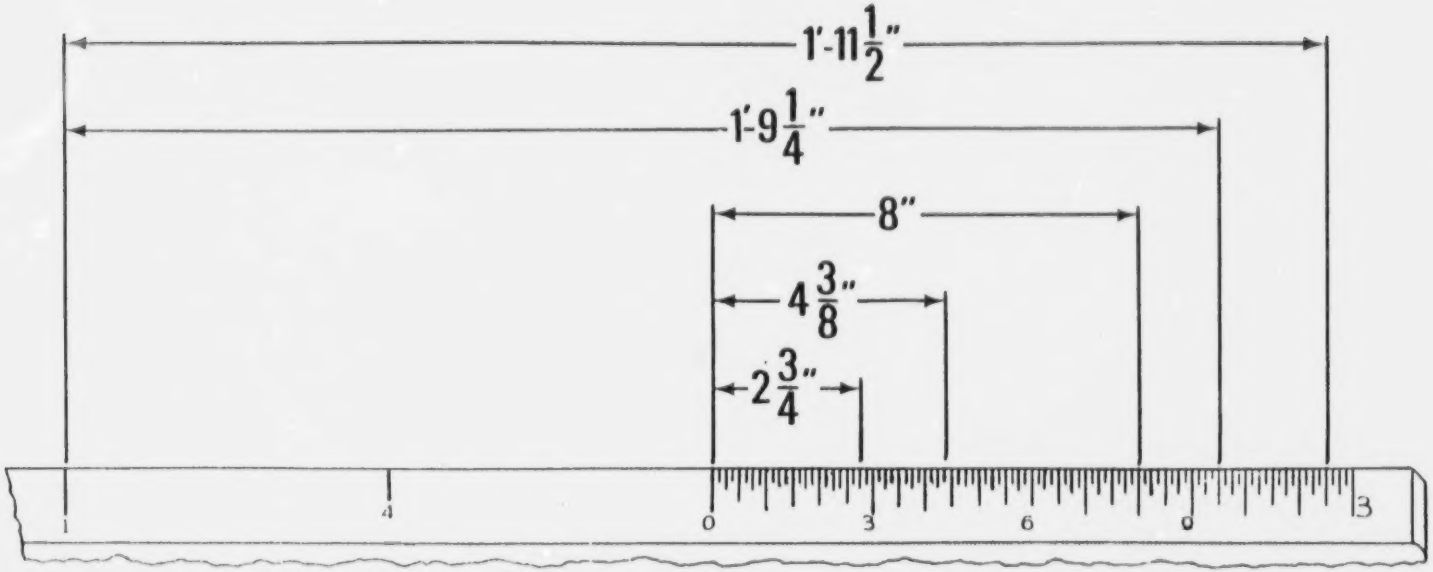
MEASUREMENTS AT SCALE OF 6" = 1' - 0" (HALF SIZE)

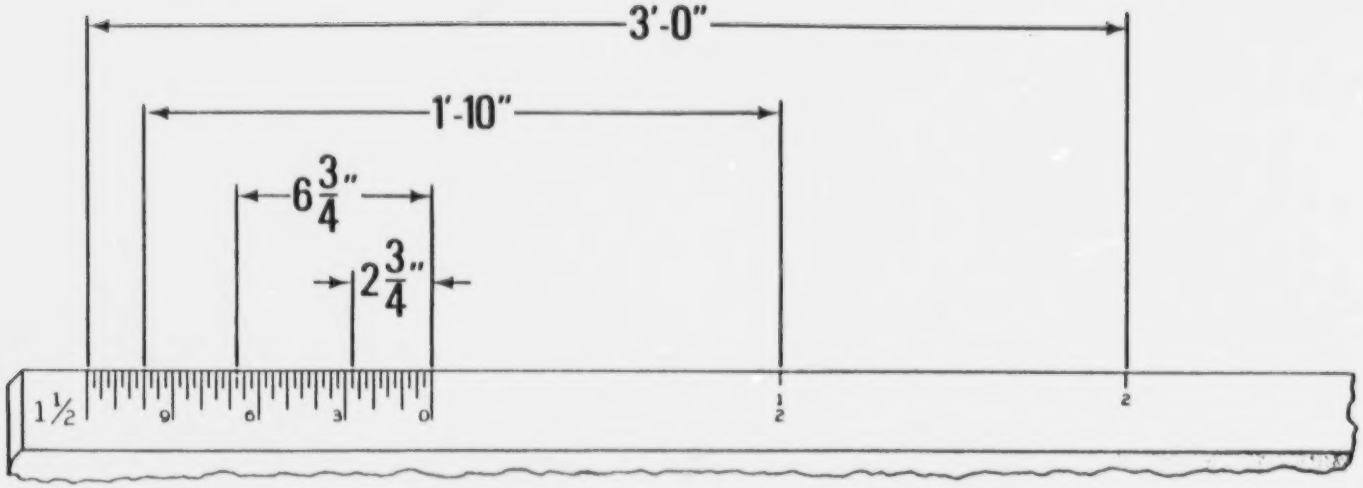


Measurements at Scale of 6" = 1'-0"

MEASUREMENTS AT SCALE OF 3" = 1' - 0" (1/4 SIZE)

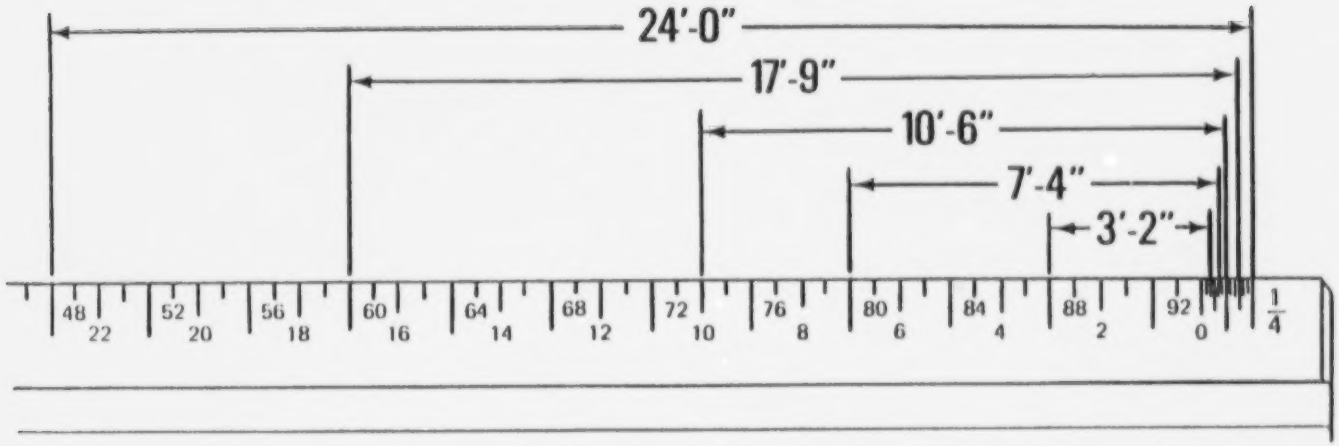


MEASUREMENTS AT SCALE OF 1 1/2 = 1' - 0" (1/8 SIZE)



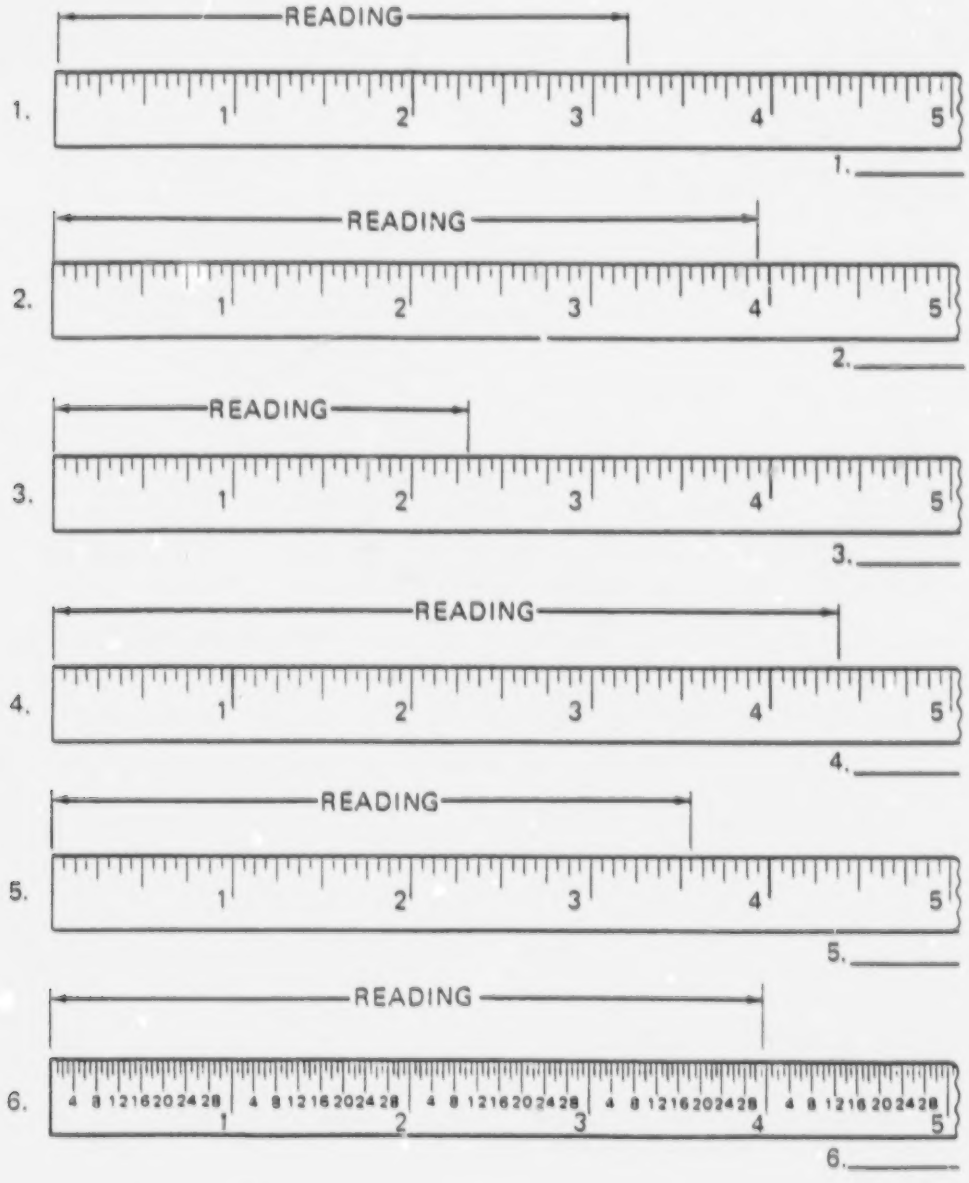
One-Eighth Scale 1½" = 1'-0"

MEASUREMENTS AT SCALE OF 1/4" = 1'0" (1/48 SIZE)



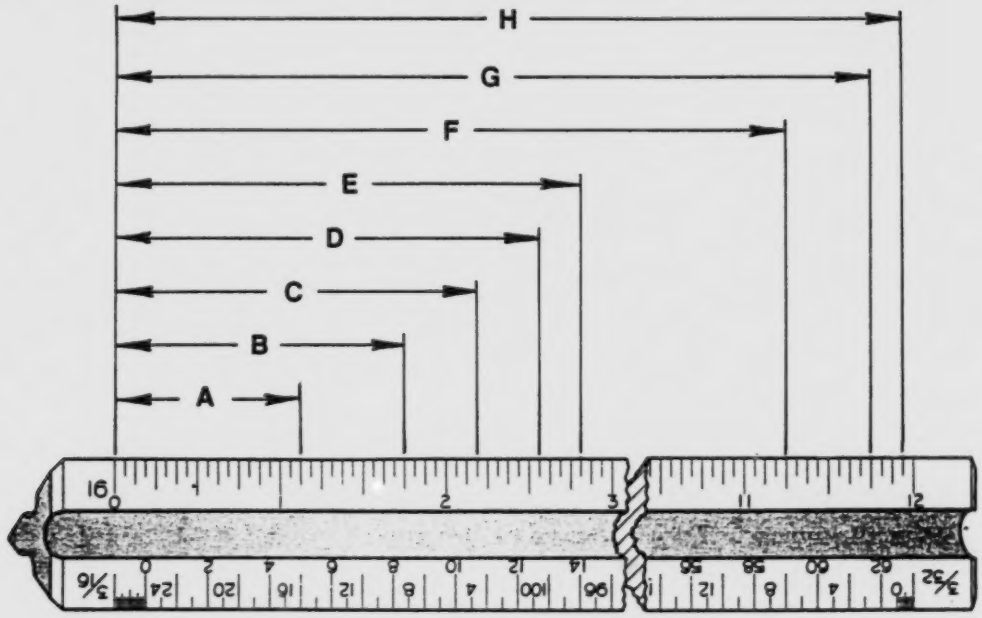
INTERPRET 1/16 and 1/32 GRADUATIONS ON A FULL SIZE METAL RULE

Directions: Read the measurements shown below at full size by reading from the left end of the rule to the points indicated by extension lines.



READ THE ARCHITECT'S SCALE AT FULL SCALE RATIO
12" = 1'-0"

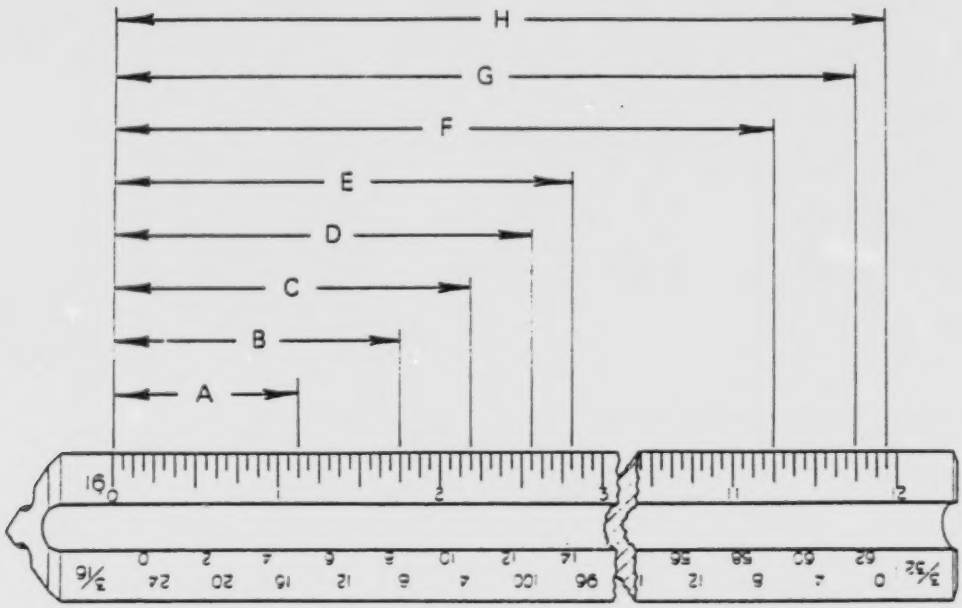
Directions: Read the measurements shown below at full scale by reading the distance from "0" at left to the points indicated on the scale with letters.



1. A =
2. B =
3. C =
4. D =
5. E =
6. F =
7. G =
8. H =

READ THE ARCHITECT'S SCALE AT THE SCALE RATIO
6" = 1'-0"

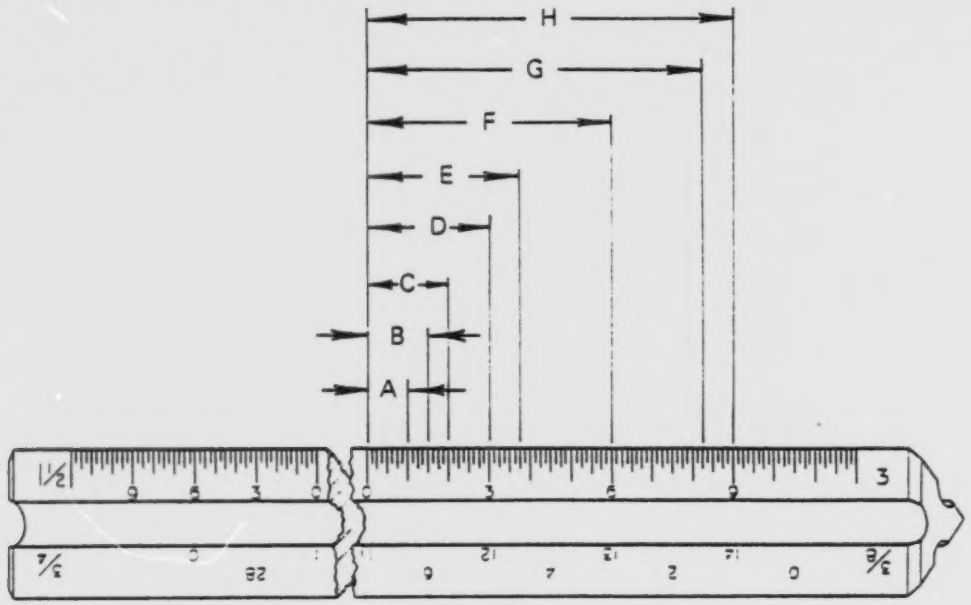
Directions: Read the measurements shown below at half scale by reading the distance from "0" at left to the points indicated on the scale with letters.



1. A =
2. B =
3. C =
4. D =
5. E =
6. F =
7. G =
8. H =

READ THE ARCHITECT'S SCALE AT THE SCALE RATIO 3" = 1'-0"

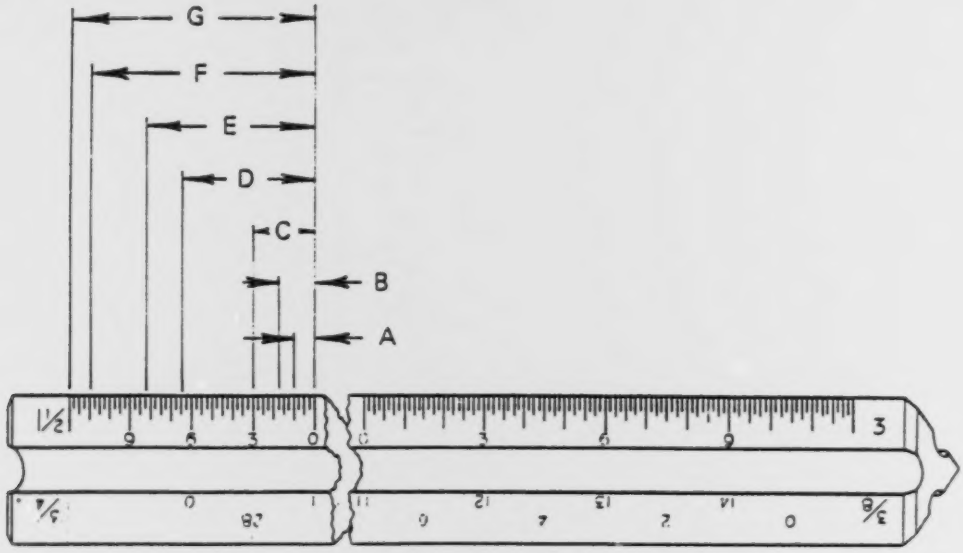
Directions: Read the measurements shown below at half scale by reading the distance from "0" at left to the points indicated on the scale with letters.



1. A =
2. B =
3. C =
4. D =
5. E =
6. F =
7. G =
8. H =

READ THE ARCHITECT'S SCALE AT THE SCALE RATIO 1 1/2" = 1'-0"

Directions: Read the measurements shown below at half scale by reading the distance from "0" at right to the points indicated on the scale with letters.



1. A =
2. B =
3. C =
4. D =
5. E =
6. F =
7. G =

MEASURE LINES ACCURATELY WITH VARIOUS SCALE RATIOS ON AN ARCHITECT'S SCALE

Directions: Measure the lines A through J to the scale heading each column in the table. Print the scale readings in the appropriate space in the table.

Example: Measure line A to the scale 3/32" = 1'- 0". A reading of 63'-6" is obtained. This dimension is printed under the 3/32" = 1'- 0" column and opposite the letter A. Use guide lines for 1/8" lettering.

NOTE: Readings must be accurate or they will be considered wrong, and lettering must be neat and correct.

A

B

C

D

E

F

G

H

I

J

LINE	3/32" = 1'-0"	1/8" = 1'-0"	1/4" = 1'-0"	3/8" = 1'-0"	1/2" = 1'-0"	1 1/2" = 1'-0"	3" = 1'-0"
A							
B							
C							
D							
E							
F							
G							
H							
I							
J							

ANSWERS TO ASSIGNMENT SHEETS 4.1 - 4.6

AS 4.1

1. 3 3/16"
2. 3 15/16"
3. 2 5/16"
4. 4 3/8"
5. 3 9/16"
6. 3 31/32"
7. 3 14/32" or 7/16"
8. 4 5/32"
9. 3 8/32" or 1/4"
10. 4 15/32"

AS 4.2

1. A = 1 1/8"
2. B = 1 3/4"
3. C = 2 3/16"
4. D = 2 9/16"
5. E = 2 13/16"
6. F = 11 1/4"
7. G = 11 3/4"
8. H = 11 15/16"

AS 4.3

1. A = 2 1/4"
2. B = 3 1/2"
3. C = 4 3/8"
4. D = 5 18"
5. E = 5 5/8"
6. F = 22 1/2" or 1'-10 1/2"
7. G = 23 1/2" or 1'-11 1/2"
8. H = 23 7/8" or 1'-11 7/8"

AS 4.4

1. A = 1"
2. B = 1 1/2"
3. C = 2"
4. D = 3"
5. E = 3 3/4"
6. F = 6"
7. G = 8 1/4"
8. H = 9"

AS 4.5

1. A = 1"
2. B = 1 3/4"
3. C = 3"
4. D = 6 1/2"
5. E = 8 1/4"
6. F = 11"
7. G = 12" or 1'-0"

LINE	3/32" = 1'-0"	1/8" = 1'-0"	1/4" = 1'-0"	3/8" = 1'-0"	1/2" = 1'-0"	1 1/2" = 1'-0"	3" = 1'-0"
A	64'-10"	48'-8"	24'-4"	16'-2¾"	12'-2"	4'-0¾"	2'-⅜"
B	51'-6"	38'-7"	19'-4"	12'-10½"	9'-7¾"	3'-2½"	1'-7¼"
C	42'-5"	31'-10"	15'-11"	10'-7¼"	7'-11½"	2'-7¾"	1'-3¾"
D	47'-0"	35'-2¼"	17'-7½"	11'-8¾"	8'-9½"	2'-11¼"	1'-5⅝"
E	57'-11"	43'-5"	21'-9"	14'-5¾"	10'-10½"	3'-7½"	1'-9¾"
F	36'-7"	27'-5"	13'-8½"	9'-1¾"	6'-10¼"	2'-3⅜"	1'-1¾"
G	24'-7"	18'-5"	9'-3"	6'-1¾"	4'-7½"	1'-7"	0'-9¼"
H	14'-4"	10'-9"	5'-4½"	3'-7"	2'-8¼"	0'-10¾"	0'-5⅜"
I	7'-9"	5'-10"	2'-11"	1'-11"	1'-5½"	0'-5¾"	0'-2⅞"
J	2'-8"	2'-0"	1'-0"	0'-8"	0'-6"	0'-2"	0'-1"

MODULE: DRAFTING FUNDAMENTALS /

UNIT IV: ARCHITECT'S SCALE USAGE

UNIT TEST

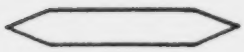
Match the term on the right with its correct definition on the left.

____	1.	An object's dimensions--the size it actually is in completed form	a.	Graduations
____	2.	An instrument used as a standard of reference when drawing an object to a proportional size	b.	Open-divided scale
____	3.	Drawing an object at a set proportion such as half its actual size, one-fourth its actual size, or double its actual size	c.	Fraction
____	4.	Dealing with the design and drawing of public and private buildings	d.	Architecture
____	5.	The subdivisions in a scale unit, all of which are equal in size or length	e.	Actual size
____	6.	A relationship between dimensional values used to reduce or enlarge the size of an object so that it can be drawn to proportion	ab.	Full-divided scale
____	7.	A part of a whole, such as 1/2 or 1/4	ac.	NTS
____	8.	A scale with the basic units subdivided throughout the length of the scale	ad.	Scale ratio
____	9.	A scale with only the end unit subdivided into fractional parts	ae.	Draw to scale
____	10.	Abbreviation meaning "not-to-scale"	bc.	Scale
____	11.	Scale used primarily for drawings of buildings, piping systems, and other large structures which must be drawn to a reduced scale to fit on a standard sheet size	bd.	Architect's scale

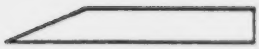
Match the terms on the right with the five basic shapes of scales on the left.

___ 12.

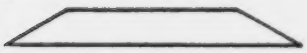
___ 13.



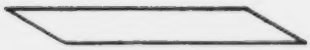
___ 14.



___ 15.



___ 16.



a. Four-bevel

b. One-bevel

c. Opposite-bevel

d. Two-bevel

e. Triangular

Match the designations on the right with the correct scale ratios on the left.

___ 17. 12" = 1'-0"

___ 18. 6" = 1'-0"

___ 19. 3" = 1'-0"

___ 20. 1 1/2" = 1'-0"

___ 21. 1" = 1'-0"

___ 22. 1/2" = 1'-0"

___ 23. 1/4" = 1'-0"

a. 1/12 size

b. 1/4 size

c. 1/48 size

d. Full size

e. 1/24 size

ab. Half size

ac. 1/8 size

Mark a "T" for correct scale usage statements and an "F" for incorrect statements.

___ 24. Select proper scale ratio

___ 25. Scale should be at a 30° angle to the line being measured

___ 26. Scales can be used as a cutting edge

___ 27. Scale should lay flat on the surface being measured

___ 28. A short dash should be made rather than a point to mark a distance

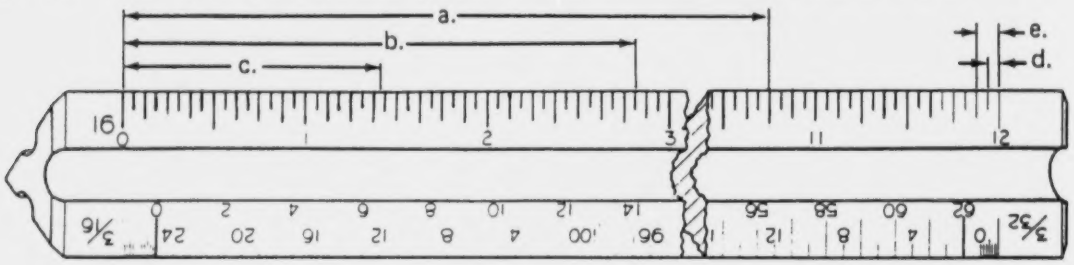
___ 29. Stick compass or divider points into scale to set instruments

___ 30. Edge of the scale should be protected to prevent damage to its graduation marks

___ 31. If a series of measurements are to be made on the full size scale, do not move scale for each measurement

___ 32. Make sure that the line of sight does not create an optical illusion

___ 33. **Interpret 1/16, 1/8 and 1/4 graduations on full size scale shown below:**



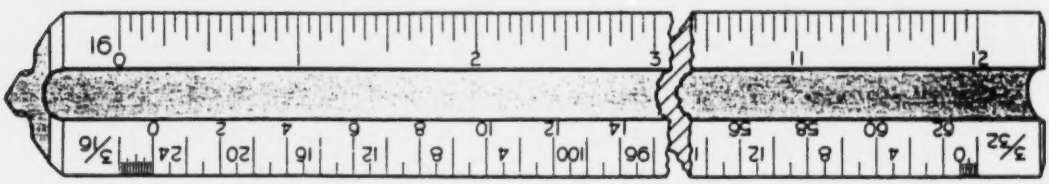
a. _____ b. _____ c. _____ d. _____ e. _____

___ 34. **Calculate and locate 1/32" graduations on the full size scale shown below by marking each dimension with a 1/8" dash and labeling the point with the correct dimension.**

a. 1 5/32"

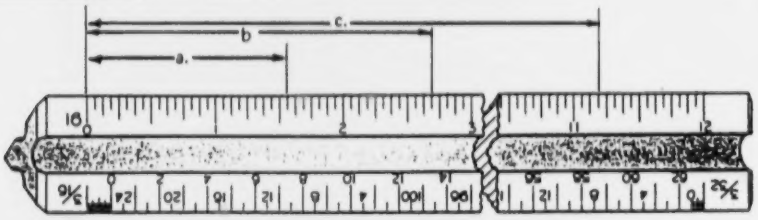
b. 2 21/32"

c. 11 13/32"



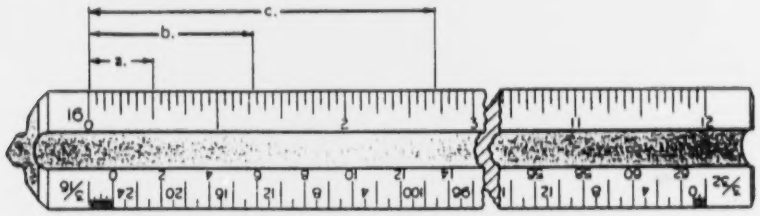
___ 35. **Read the architect's scale at full scale ratio 12" = 1'- 0"**

a._____ b._____ c._____



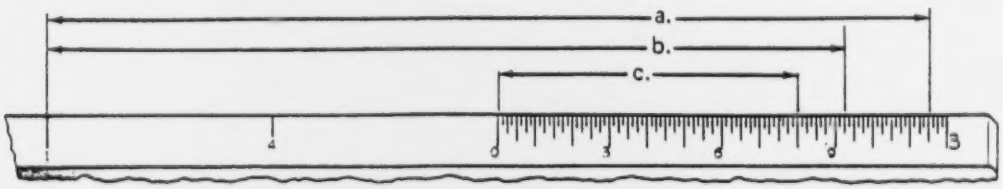
___ 36. **Read the architect's scale at the scale ratio 6" = 1'- 0"**

a._____ b._____ c._____



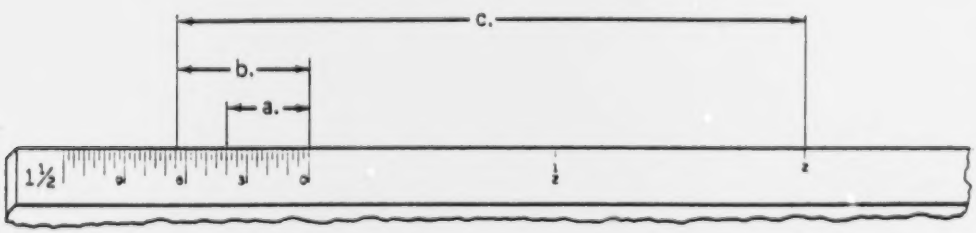
___ 37. **Read the architect's scale at the scale ratio 3" = 1'- 0".**

a._____ b._____ c._____



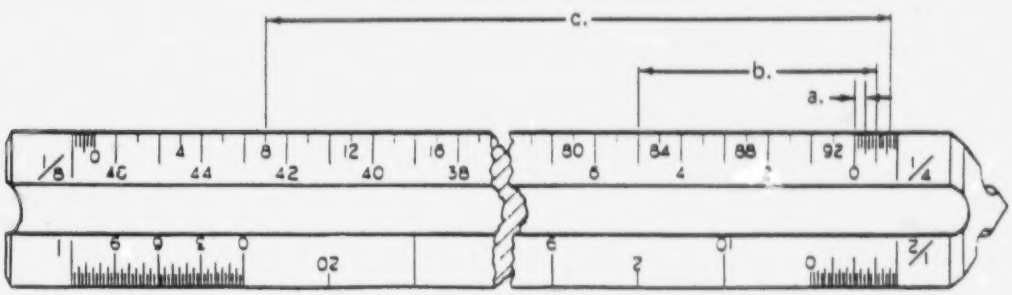
___ 38. **Read the architect's scale at the scale ratio 1½" = 1'- 0".**

a. _____ b._____ c._____



39. **Read the architect's scale at the scale ratio 1/4" = 1'- 0".**

a. _____ b. _____ c. _____

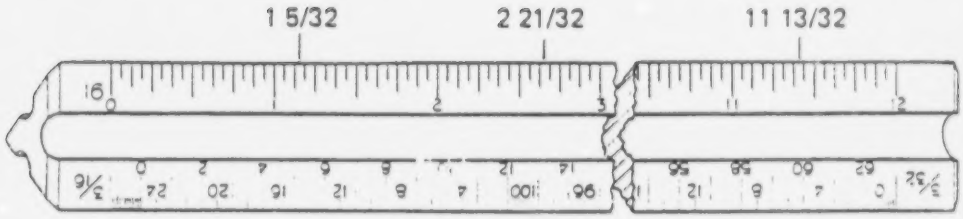


ANSWERS TO UNIT IV TEST (C4)

1. e
2. bc
3. ae
4. d
5. a
6. ad
7. c
8. ab
9. b
10. ac
11. bd
12. e
13. a
14. b
15. d
16. c
17. d
18. ab
19. b
20. ac
21. a
22. e
23. c
24. T
25. F
26. F
27. T
28. T
29. F
30. T
31. T
32. T

33. a. 10 3/4"
    b. 2 13/16"
    c. 1 13/32"
    d. 1/16"
    e. 1/8"

34.



35. a. 1 9/16"
    b. 2 11/16"
    c. 11 3/16"

36. a. 1"
    b. 2 9/16"
    c. 5 3/8"

37. a. 1' - 11 1/2"
    b. 1' - 9 1/4"
    c. 8"

38. a. 4"
    b. 6 1/2"
    c. 2' - 6 1/2"

39. a. 3"
    b. 5' - 6"
    c. 43' - 10"

MODULE: DRAFTING FUNDAMENTALS

UNIT V: CIVIL ENGINEER'S SCALE USAGE

UNIT OBJECTIVE

After completion of this unit, the student should be able to describe a civil engineer's scale, select rules for its correct usage, and interpret scale graduations. The student should also be able to read a civil engineer's scale in various scale ratios. This knowledge will be evidenced by correctly performing the procedures outlined on the assignment sheets and by scoring ____ percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

5.1 Identify the correct description of a civil engineer's scale.

5.2 State the purpose for using a civil engineering scale.

5.3 List scale divisions that are found on a civil engineer's scale.

5.4 Interpret scale graduations found on a civil engineer's scale.

5.5 Demonstrate the ability to:

a. Read the civil engineer's scale using a scale ratio of 1" = 1'-0".

b. Read the civil engineer's scale using a scale ratio of 1" = 20'.

c. Read the civil engineer's scale using a scale ratio of 1" = 30'.

d. Read the civil engineer's scale using a scale ratio of 1" = 40'.

e. Read the civil engineer's scale using a scale ratio of 1" = 50'.

f. Read the civil engineer's scale using a scale ratio of 1" = 60'.

g. Measure lines accurately with various scale ratios on a civil engineer's scale.

MODULE: DRAFTING FUNDAMENTALS

UNIT V: CIVIL ENGINEER'S SCALE USAGE

CONTENTS OF THIS UNIT

A. Objective sheet

B. References

C. Notes to the instructor

D. Lesson plans

1. Lesson 1: USING THE CIVIL ENGINEER'S SCALE

   a. Information outline

   b. Transparency masters

      TM 5.1: Civil Engineer's Scale
      TM 5.2: Civil Engineer's Scale (Continued)

   c. Assignment sheets

      AS 5.1: Read the Civil Engineer's Scale Using a Scale Ratio of 1" = 1'-0"
      AS 5.2: Read the Civil Engineer's Scale Using a Scale Ratio of 1" = 20'
      AS 5.3: Read the Civil Engineer's Scale Using a Scale Ratio of 1" = 30'
      AS 5.4: Read the Civil Engineer's Scale Using a Scale Ratio of 1" = 40'
      AS 5.5: Read the Civil Engineer's Scale Using a Scale Ratio of 1" = 50'
      AS 5.6: Read the Civil Engineer's Scale Using a Scale Ratio of 1" = 60'
      AS 5.7: Measure Lines Accurately with Various Scale Ratios on a Civil Engineer's Scale

   d. Answers to assignment sheets

E. Unit test

F. Answers to unit test

REFERENCES

1. Brown, Walter C. Drafting for Industry. South Holland, IL 60473: The Goodheart-Willcox Company, Inc., 1974.

2. Davis, Ronald, Bill Hill, and Bruce Yancey. Basic Drafting: Book One. Stillwater Okla. 74074: Mid-America Vocational Curriculum Consortium, Inc., 1981.

3. Dygdon, John Thomas and Henry Cecil Spencer. Basic Technical Drawing. New York, NY 10022: Macmillan Publishing Co., Inc., 1968.

4. Gerevas, Lawrence E. Drafting Technology Problems. 2nd ed. Napa, CA: Bobbs-Merrill Educational Publishing, 1981.

5. Giesecke, Frederick E., et al. Technical Drawing. New York, NY 10022: Macmillan Publishing Co., Inc., 1980.

6. Jensen, Cecil and Jay Helsel. Engineering Drawing and Design. New York, NY: Gregg Division/McGraw-Hill Book Company, 1979.

7. Spence, William P. Drafting Technology and Practice. Revised ed. Pittsburg, Kan. 66762: Bennett & McKnight Publishing Company, 1980.

8. Wallach, Paul Ross. Drafting Problems, 2nd ed. Mission Hills, Calif. 91345: Glencoe Publishing Company, 1988.

NOTES TO THE INSTRUCTOR

A. Suggested approaches to teaching this unit:

1. Invite resource person to attend class and discuss use and types of scales.

2. Lead discussion on the advantages and disadvantages of different types of scales.

3. Provide problems for the students to use in practicing using the civil engineer's scale.

MODULE: DRAFTING FUNDAMENTALS

UNIT V: CIVIL ENGINEER'S SCALE USAGE

LESSON 1: USING THE CIVIL ENGINEER'S SCALE

I. Terms and definitions

A. Civil engineering--design and construction of public works, transportation systems, environmental systems, and other systems

II. Description of civil engineer's scale--scale used for civil engineer work; it is graduated in units of one inch divided into 10, 20, 30, 40, 50, and 60 parts (TM 5.1 and 5.2)

NOTE: It is used in drawing maps to scales of 1" = 50', 1" = 500', 1" = 5 miles, etc

III. Purpose for using a civil engineer's scale--to provide a standard of reference that is needed when drawing civil projects

NOTE: It allows areas and objects that are too large to be drawn actual size to be drawn to a usable proportion

IV. Scale divisions found on an engineer's scale

A. 10 scale: 1" subdivided in 10 parts

B. 20 scale: 1" subdivided in 20 parts

C. 30 scale: 1" subdivided in 30 parts

D. 40 scale: 1" subdivided in 40 parts

E. 50 scale: 1" subdivided in 50 parts

F. 60 scale: 1" subdivided in 60 parts

V. How to interpret graduations on the civil engineer's scale

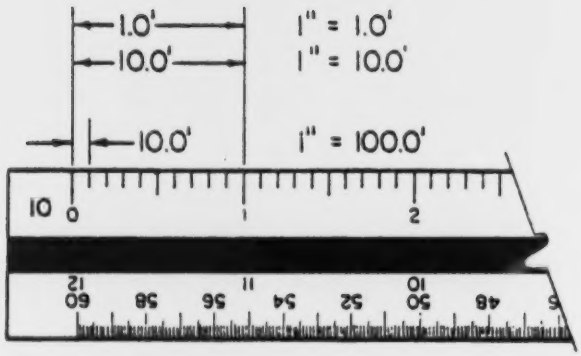
A. 1" = 1' scale ratio

1. Measurement is made by reading directly from the full size scale marked 10

2. This is a full divided scale with each divided into 10 units of 1/10 inch

NOTE: This scale can be used for various ratios, such as 1" = 1', 1" = 10', 1" = 100', or 1" = 1,000'

Example: On the 1" = 1' scale ratio, each division represents 1/10 of a foot, so a line containing 10 units would be 10/10 long or 1' long; on the 1" = 100' scale ratio, each division represents 1/10 of 100', so each division is 10' long



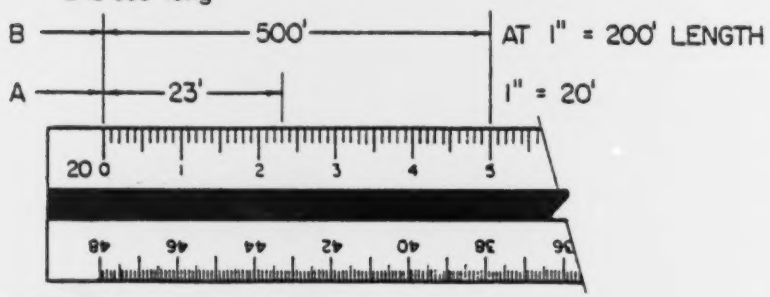
B. 1" = 20' scale ratio

1. Measurement is made by reading directly from the scale marked 20

2. This is a full divided scale with each inch divided into 20 units of 1/20 inch

NOTE: This scale can be used for various ratios such as 1" = 20', 1" = 200', or 1" = 2000'

Example: On the 1" = 20' scale ratio, each division represents 1/20 of 20' or one foot, so because it contains 23 units, line A is 23' long; on the 1" = 200' scale ratio, each division represents 1/20 of 200' or ten feet, so since it contains 50 units, line B is 500' long



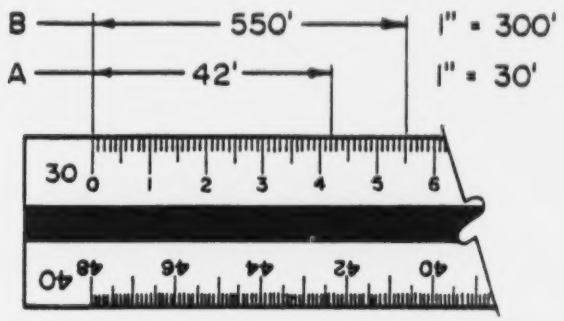
C. 1" = 30' scale

1. Measurement is made by reading directly from the scale marked 30

2. This is a full divided scale with each inch divided into 30 units of 1/30 inch

NOTE: This scale can be used for various ratios such as 1" = 30', 1" = 300', 1" = 3,000'

Example: On the 1" = 30' scale ratio, each division represents 1/30 of 30' or one foot, so because it contains 42 units, line A is 42' long; on the 1" = 300' scale ratio, each division represents 1/30 or 300' or ten feet, so since it contains 55 units, line B is 550' long



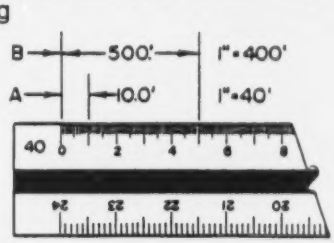
D. 1" = 40' scale ratio

1. Measurement is made by reading directly from the scale marked 40

2. This is a full divided scale with each inch divided into 40 units of 1/40 inch

NOTE: This scale can be used for various ratios such as 1" = 40', 1" = 400', or 1" = 4,000'

Example: On the 1" = 40' scale ratio, each division represents 1/40 of 40' or one foot, so since it contains 10 units, line A is 10' long; on the 1" = 400' scale ratio, each division represents 1/40 of 400' or ten feet, so since it contains 50 units, line B is 500' long



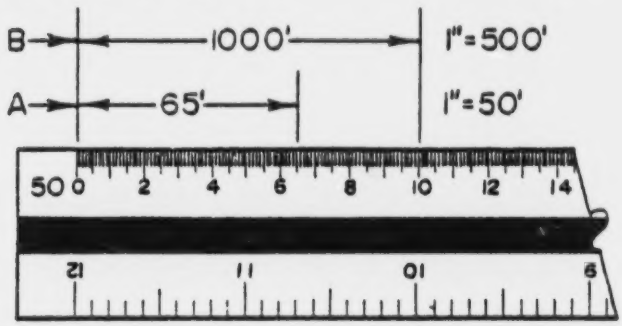
E. 1" = 50' scale

1. Measurement is made by reading directly from the scale marked 50

2. This is a full divided scale with each inch divided into 50 units of 1/50 inch

NOTE: This scale can be used for various ratios such as 1" = 50', 1" = 500', 1" = 5,000'

Example: On the 1" = 50' scale ratio, each division represents 1/50 of 50' or one foot, so since it contains 65 units, line A is 65' long; on the 1" = 500' scale ratio, each division represents 1/50 or 500' or ten feet, so since it contains 1,000 units, line B is 1,000' long



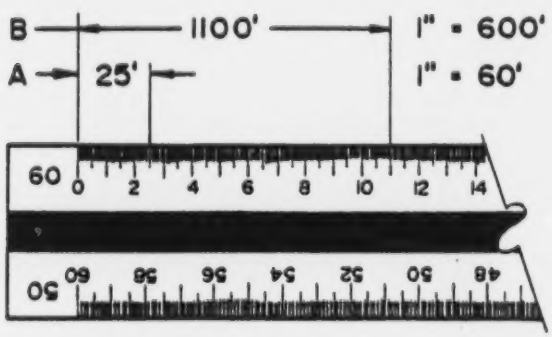
F. 1" = 60' scale

1. Measurement is made by reading directly from the scale marked 60

2. This is a full divided scale with each inch divided into 60 units of 1/60 inch

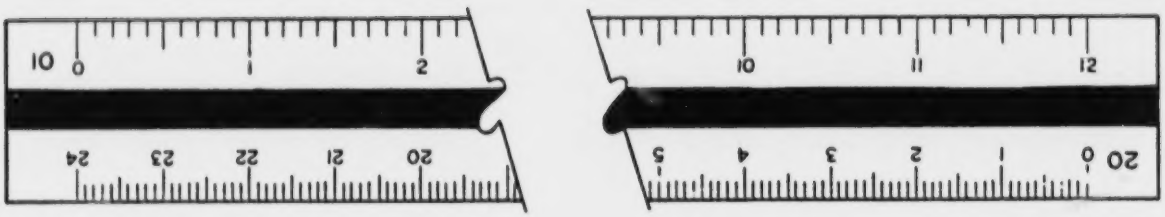
NOTE: This scale can be used for various ratios such as 1" = 60', 1" = 600', 1" = 6,000'

Example: On the 1" = 60' scale ratio, each division represents 1/60 of 60' or one foot, so since it contains 25 units, line A is 25' long; on the 1" = 600' scale ratio, each division represents 1/60 or 600' or ten feet, so since it contains 110 units, line B is 1,100' long



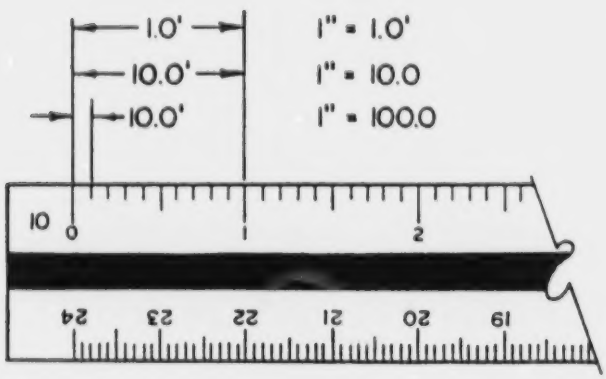
TM 5.1

CIVIL ENGINEER'S SCALE

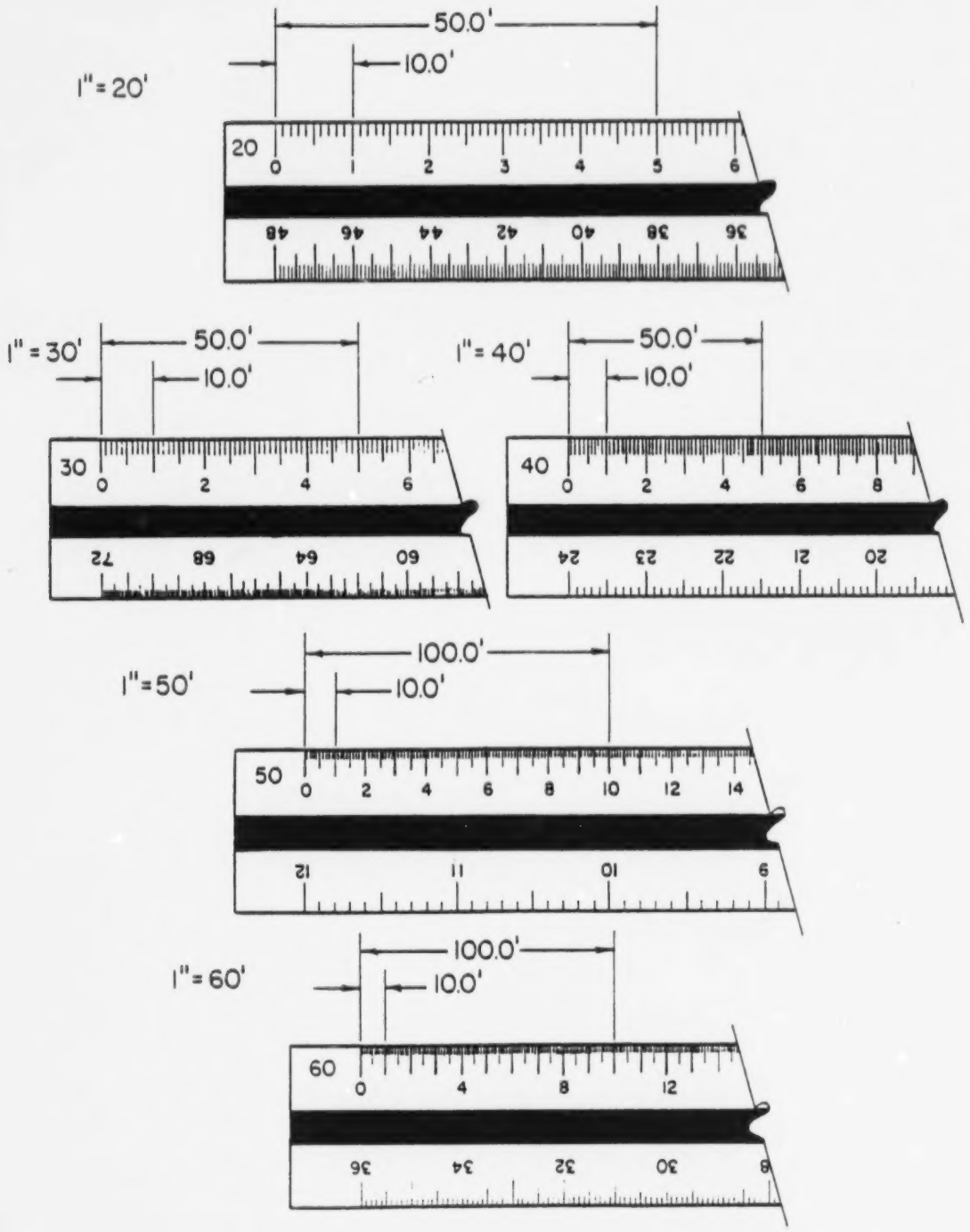


Examples for Reading

This scale can be used to read

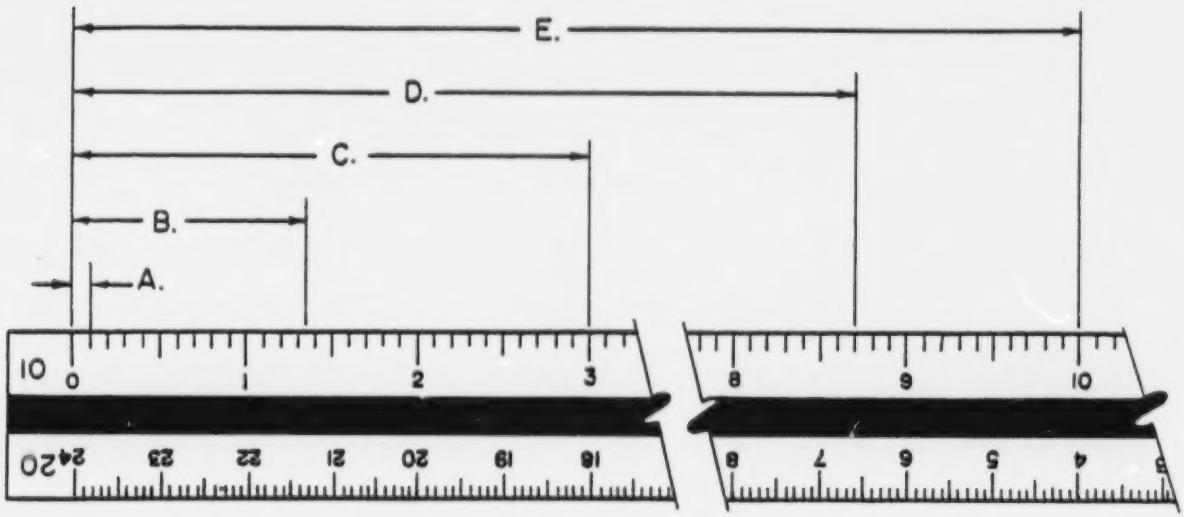


CIVIL ENGINEER'S SCALE (CONTINUED)



READ THE CIVIL ENGINEER'S SCALE USING SCALE RATIO OF 1" = 1'-0"

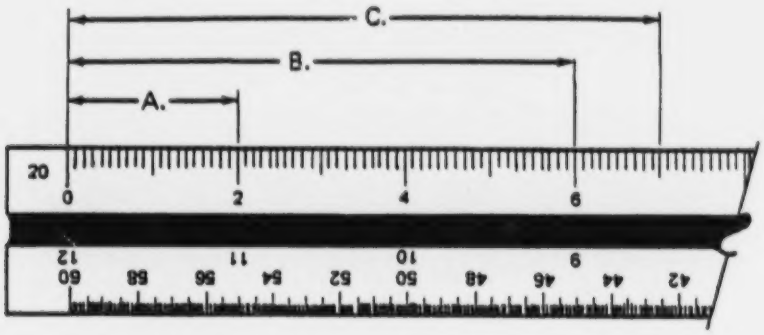
Directions: Read the measurements shown below at 1" = 1' -0" scale reading the distance from 0 at left to points indicated on the scale. Place the correct measurements in the blanks below the scale.



1. A = _____
2. B = _____
3. C = _____
4. D = _____
5. E = _____

READ THE CIVIL ENGINEER'S SCALE USING SCALE RATIO OF 1" = 20'

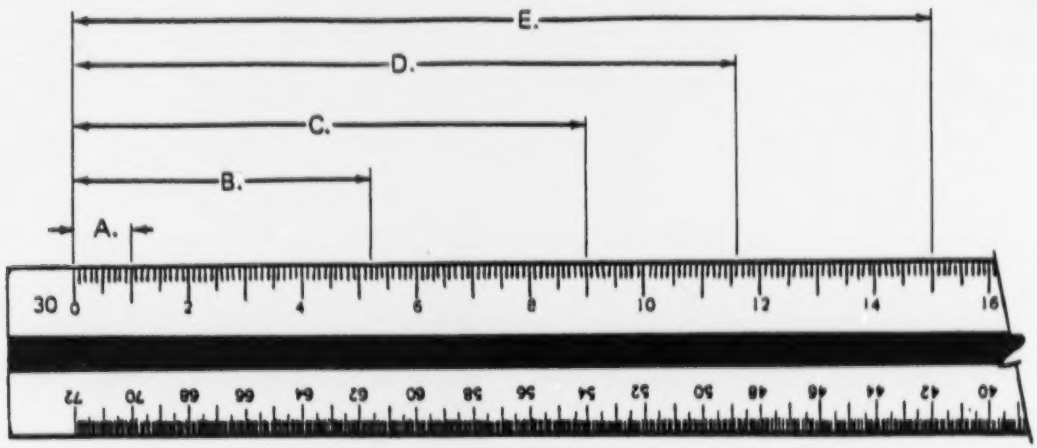
Directions: Read the following scale from distance at left to points indicated. Place the correct measurements in the blanks below the scale.



1. A = _____
2. B = _____
3. C = _____

READ THE CIVIL ENGINEER'S SCALE USING SCALE RATIO OF 1" = 30'

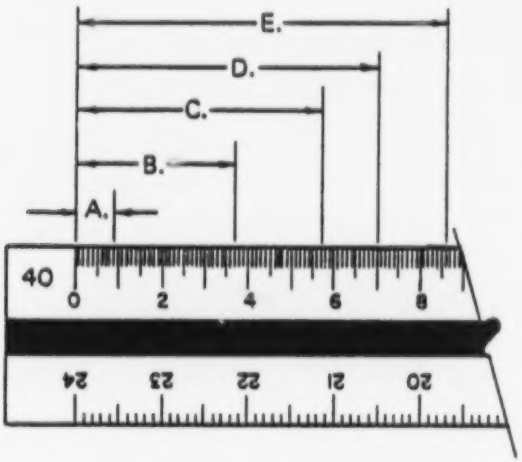
Directions: Read the measurements shown below at 1" = 30' scale reading the distance from 0 at left to points indicated on the scale. Place the correct measurements in the blanks below the scale.



1. A = _____
2. B = _____
3. C = _____
4. D = _____
5. E = _____

READ THE CIVIL ENGINEER'S SCALE USING SCALE RATIO OF 1" = 40'

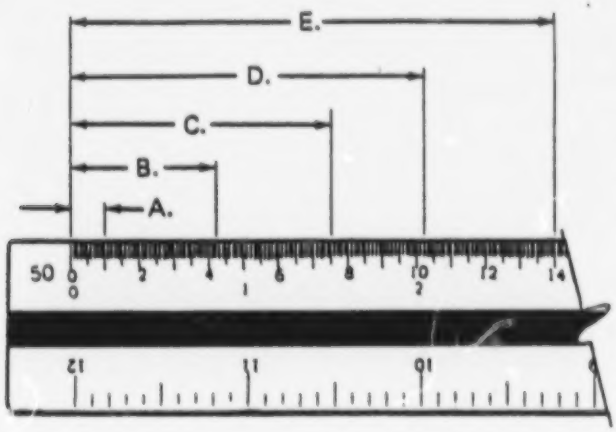
Directions: Read the measurements shown below at 1" = 40' scale reading the distance from 0 at left to points indicated on the scale. Place the correct measurements in the blanks below the scale.



1. A = _____
2. B = _____
3. C = _____
4. D = _____
5. E = _____

READ THE CIVIL ENGINEER'S SCALE USING SCALE RATIO OF 1" = 50'

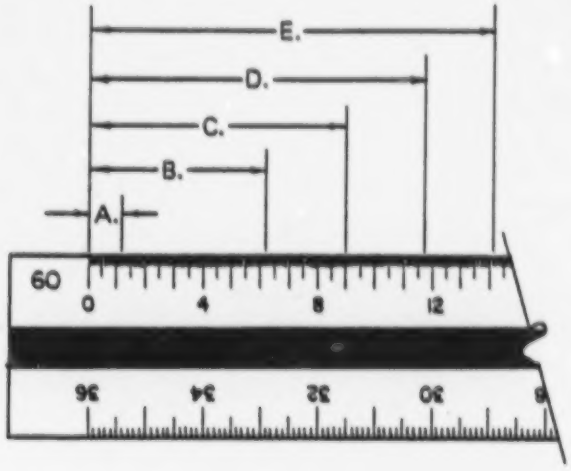
Directions: Read the measurements shown below at 1" = 50' scale reading the distance from 0 at left to points indicated on the scale. Place the correct measurements in the blanks below the scale.



1. A = _____
2. B = _____
3. C = _____
4. D = _____
5. E = _____

READ THE CIVIL ENGINEER'S SCALE USING SCALE RATIO OF 1" = 60'

Directions: Read the measurements shown below at 1" = 60' scale reading the distance from 0 at left to points indicated on the scale. Place the correct measurements in the blanks below the scale.

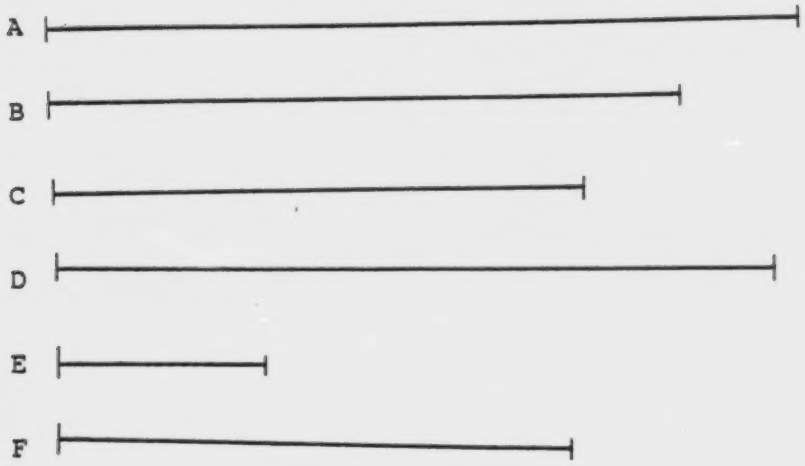


1. A = _____
2. B = _____
3. C = _____
4. D = _____
5. E = _____

MEASURE LINES ACCURATELY WITH VARIOUS SCALE RATIOS ON A CIVIL ENGINEER'S SCALE

Directions: Measure the lines A through F to the scale ratio heading each column in the table. Letter the scale readings in the appropriate space in table using guidelines for 1/8" lettering.

Example: On a 1" = 10' scale ratio, line A would be 55' long; this figure should be lettered under the 1" = 10' column opposite letter A.



	1"=10'	1"= 20'	1"=300'	1"=40'	1"=500'	1"=60'	1"=10 MILES
A							
B							
C							
D							
E							
F							

ANSWERS TO ASSIGNMENT SHEETS 5.1 - 5.7

AS 5.1

1. A = .1'
2. B = 1.35'
3. C = 3'
4. D = 8.7'
5. E = 10'

AS 5.2

1. A = 20'
2. B = 60'
3. C = 70'

AS 5.3

1. A = 10'
2. B = 52'
3. C = 90'
4. D = 116'
5. E = 150'

AS 5.4

1. A = 9'
2. B = 37'
3. C = 57'
4. D = 70'
5. E = 86'

AS 5.5

1. A = 10'
2. B = 42'
3. C = 75'
4. D = 107'
5. E = 140'

AS 5.6

1. A = 12'
2. B = 72'
3. C = 90'
4. D = 117'
5. E = 141'

AS 5.7

	1"=10'	1"= 20'	1"=300'	1"=40'	1"=500'	1"=60'	1"=10 MILES
A	44'	88'	1320'	176'	2200'	264'	44 miles
B	37'	74'	1110'	148'	1850'	222'	37 miles
C	31'	62'	930'	124'	1550'	186'	31 miles
D	42'	84'	1260'	168'	2100'	252'	42 miles
E	12'	24'	360'	48'	600'	72'	12 miles
F	30'	60'	900'	120'	1500'	180'	30 miles

MODULE: DRAFTING FUNDAMENTALS

UNIT V: CIVIL ENGINEER'S SCALE USAGE

UNIT TEST

Select the option which best completes the question or statement.

____ 1. Which of the following statements describes the civil engineer's scale?

a. A scale used primarily for drawings of buildings, piping systems and other large structures

b. A scale divided into units representing full size (1" = 1"), half size (1/2" = 1"), quarter size (1/4" = 1"), and one-eighth size (1/8" = 1")

c. A scale graduated in units of one inch divided into 10, 20, 30, 40, 50, and 60 parts

d. A scale that has one full-size scale and ten reduced-size scales

____ 2. Which of the following statements describes civil engineering?

a. Design and drawing of public and private buildings

b. Design and construction of public works, transportation systems, environmental systems and other systems

c. Design and application of circuitry and equipment for power generation

3. **List size scale divisions that are found on a civil engineer's scale.**

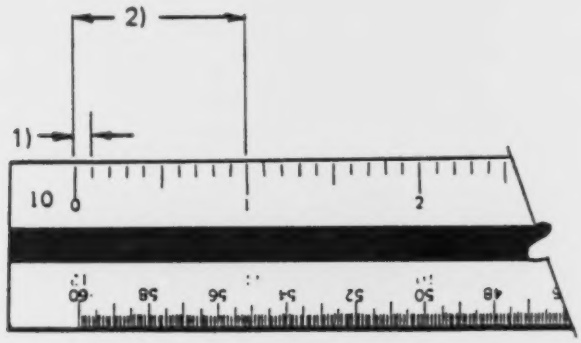
a. _____ d. _____

b. _____ e. _____

c. _____ f. _____

4. **Interpret graduations on a civil engineer's scale.**

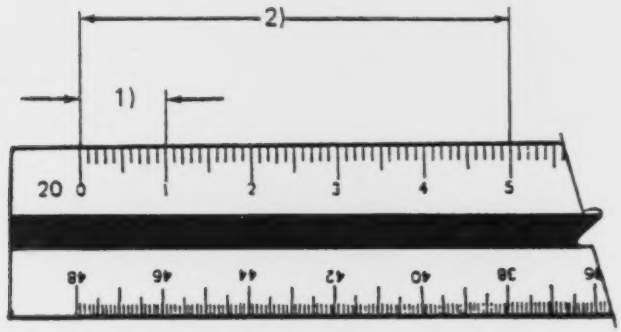
a. 1" = 10'



1) _____

2) _____

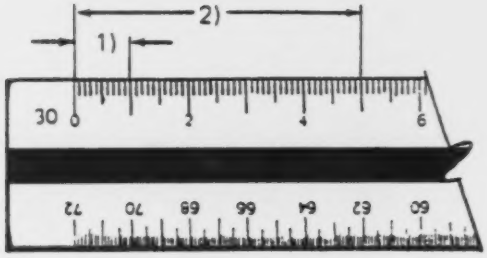
b. 1" = 20'



1) _____

2) _____

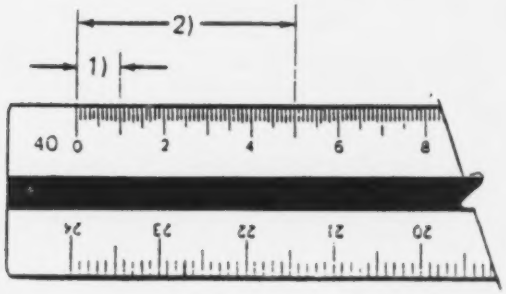
c. 1" = 30'



1) _____

2) _____

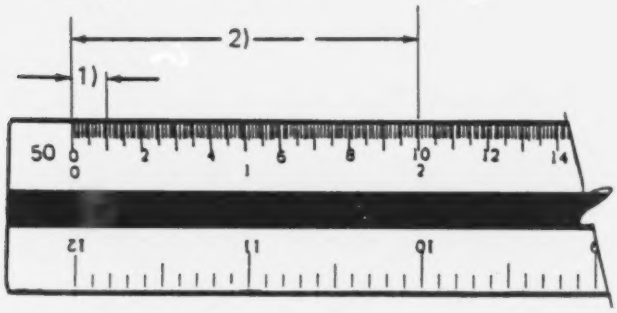
d. 1" = 40'



1) _____

2) _____

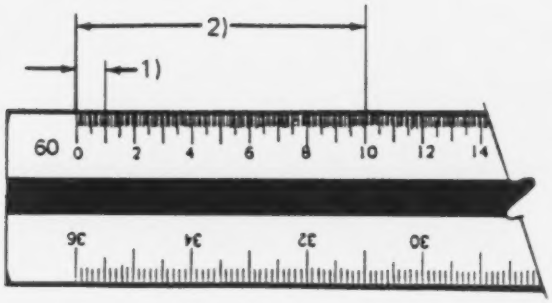
e. 1" = 500'



1) _____

2) _____

f. 1" = 60'



1) _____

2) _____

ANSWERS TO UNIT V TEST (C4)

1. c

2. b

3. The following in any order:

   a. 10 scale--1" subdivided in 10 parts

   b. 20 scale--1" subdivided in 20 parts

   c. 30 scale--1" subdivided in 30 parts

   d. 40 scale--1" subdivided in 40 parts

   e. 50 scale--1" subdivided in 50 parts

   f. 60 scale--1" subdivided in 60 parts

4. a. 1" = 10'

      1) 1'
      2) 10'

   b. 1" = 20'

      1) 10'
      2) 50'

   c. 1" = 30'

      1) 10'
      2) 50'

   d. 1" = 40'

      1) 10'
      2) 50'

   e. 1" = 500'

      1) 100'
      2) 1,000'

   f. 1" = 60'

      1) 10'
      2) 100'

MODULE: DRAFTING FUNDAMENTALS

UNIT VI: MECHANICAL ENGINEER'S SCALE USAGE

UNIT OBJECTIVE

After completion of this unit, the student should be able to describe a mechanical engineer's scale and state the purpose for using one. The student should also be able to list ratios found on a mechanical engineer's scale and read the ratio scales correctly when measuring lines. This knowledge will be evidenced by correctly performing the procedures outlined on the assignment sheets and by scoring ____ percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

6.1 Identify the correct description of a mechanical engineer's scale.

6.2 State the purpose for using a mechanical engineer's scale.

6.3 List four scale ratios that are found on a mechanical engineer's scale.

6.4 Interpret scale graduations found on a mechanical engineer's scale.

6.5 Demonstrate the ability to:

a. Read the mechanical engineer's scale at the scale ratio of 1" = 1" (Full size)

b. Read the mechanical engineer's scale at the scale ratio of 1/2" - 1" (Half size)

c. Read the mechanical engineer's scale at the scale ratio of 1/4" - 1" (Quarter size)

d. Read the mechanical engineer's scale at the scale ratio of 1/8" = 1" (One-eighth size)

e. Measure lines accurately with various scale ratios on a mechanical engineer's scale

CONTENTS OF THIS UNIT

A. Objective sheet

B. References

C. Notes to the instructor

D. Lesson plans

1. Lesson 1: USING THE MECHANICAL ENGINEER'S SCALE

   a. Information outline

   b. Transparency master

      TM 6.1: Mechanical Engineer's Scale

   c. Assignment sheets

      AS 6.1: Read the Mechanical Engineer's Scale Using a Scale Ratio of 1" = 1" (Full size)
      AS 6.2: Read the Mechanical Engineer's Scale Using a Scale Ratio of 1/2" = 1" (Half size)
      AS 6.3: Read the Mechanical Engineer's Scale Using a Scale Ratio of 1/4" = 1" (Quarter size)
      AS 6.4: Read the Mechanical Engineer's Scale Using a Scale Ratio of 1/8" = 1" (One-eighth size)
      AS 6.5: Measure Lines Accurately with Various Scale Ratios on a Mechanical Engineer's Scale

E. Unit test

F. Answers to unit test

REFERENCES

1. Brown, Walter C. Drafting for Industry. South Holland, Ill. 60473: The Goodheart-Wilcox Company, Inc., 1974.

2. Davis, Ronald, Bill Hill, and Bruce Yancey. Basic Drafting: Book One. Stillwater Okla., 74074: Mid-America Vocational Curriculum Consortium, Inc., 1981.

3. Dygdon, John Thomas and Henry Cecil Spencer. Basic Technical Drawing. New York 10022: Macmillan Publishing Co., Inc., 1968.

4. Giesecke, Frederick E., et al. Technical Drawing. New York 10022: Macmillan Publishing Co., Inc., 1980.

5. Jensen, Cecil and Jay Helsel. Engineering Drawing and Design. New York: Gregg Division/McGraw-Hill Book Company, 1979.

6. Spence, William P. Drafting Technology and Practice. Revised ed. Pittsburgh, Kan. 66762: Bennett & McKnight Publishing Company, 1980.

7. Wallach, Paul Ross. Drafting Problems, 2nd ed. Mission Hills, Calif. 91345: Glencoe Publishing Company, 1988.

8. Gerevas, Lawrence E. Drafting Technology Problems, 2nd ed. Napa, Calif.: Bobbs-Merrill Educational Publishing, 1981.

NOTES TO THE INSTRUCTOR

A. Suggested approaches to teaching this unit

1. Provide practice activities for students to use in increasing their skill with the mechanical engineer's scale.

MODULE: DRAFTING FUNDAMENTALS

UNIT VI: MECHANICAL ENGINEER'S SCALE USAGE

LESSON 1: USING THE MECHANICAL ENGINEER'S SCALE

I. Terms and definitions (TM 6.1)

A. Mechanical engineer's scale--A scale commonly used by mechanical drafters because of its scale ratios; the mechanical engineer's scale is divided into units representing full size (1" = 1"), half size (1/2" = 1"), quarter size (1/4" = 1"), and one- eighth size (1/8" = 1")

NOTE: The mechanical engineer's scale is sometimes called a mechanical drafter's scale

II. Purpose for using a mechanical engineer's scale--To provide a standard of reference that is needed when drawing mechanical parts where the dimensions are in inches or fractions

NOTE: It allows objects that are too large or too small to be drawn actual size to be drawn to a usable proportion

III. Scale ratios found on a mechanical engineer's scale

A. 1" = 1" -- Full size

B. 1/2" = 1" -- Half size

C. 1/4" = 1" -- Quarter size

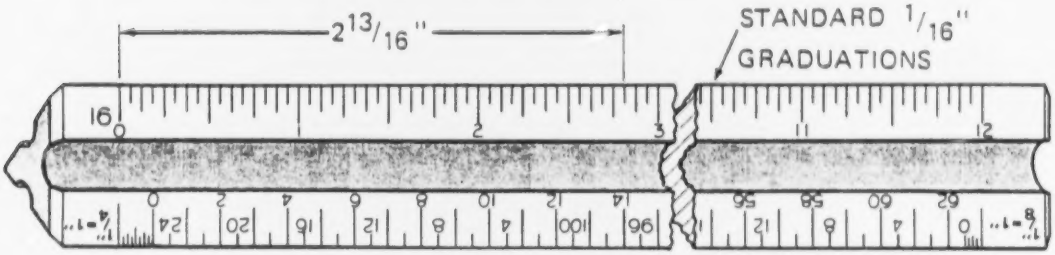
D. 1/8" = 1" -- One-eighth size

NOTE: On some mechanical engineer's scales you will find a 3/8" = 1", and 3/4" = 1", but these are not considered standard reduction scales

IV. How to interpret scale graduations found on the mechanical engineer's scale

A. 1" = 1" (**Full size**)--Measurement is made by reading directly from full size scale in inches and fractions

Example: To measure the distance indicated on the scale below, start at 0 and the point being measured (in this case it is 2"); next, determine the number of 1/16" units between the last full inch and the point being measured (in this case there are thirteen 1/16" units), add the inches and the fraction, and the measurement is 2 13/16"

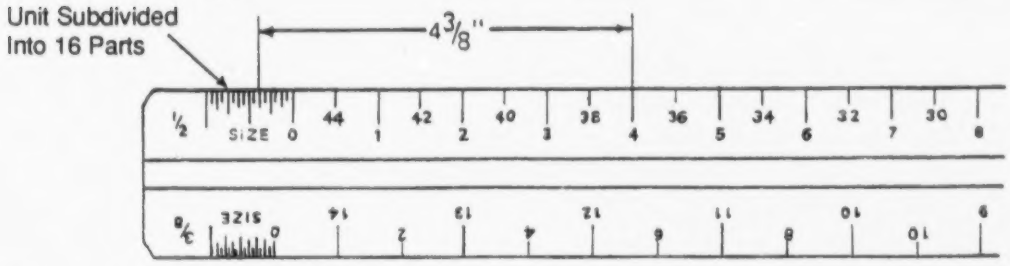


B. 1/2" = 1" **(Half size)**

1. When measuring a given line on a scale ratio of 1/2" = 1", use the scale marked 1/2"

2. The subdivisions to the left of 0 represent one inch compressed to a 1/2" length in 16 units which represent 1/16"

Example: To measure the distance indicated on the scale below, lay the 1/2" scale parallel to the line being measured, then move the scale to the right until it shows only the full inches to the right of 0 (in this case it is 4"); next, read the subdivisions to the left of 0 to determine the inches and fractions of an inch (in this case it is 6/16 or 3/8") which when added to the full inches will give a reading of 4 3/8"

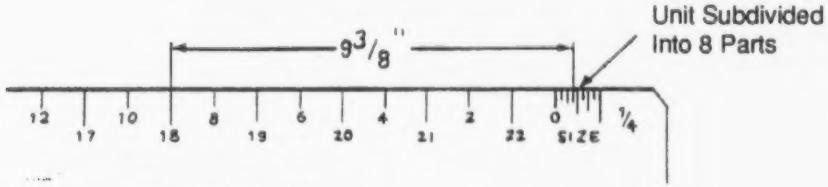


C. 1/4" = 1" **(Quarter size)**

1. When measuring a given line on a scale ratio of 1/4" = 1", use the scale marked 1/4"

2. The subdivisions to the right of 0 represents one inch compressed to a 1/4" length in 8 units which represent 1/8"

Example: To measure the distance indicated on the scale below, lay the 1/4" scale parallel to the line being measured, then move the scale to the left until it shows only the full inches to the left of 0 (in this case it is 9"); next, read the subdivisions to the right of 0 to determine the inches and fractions of an inch (in this case it is 3/8") which when added to the full inches will give a reading of 9 3/8"

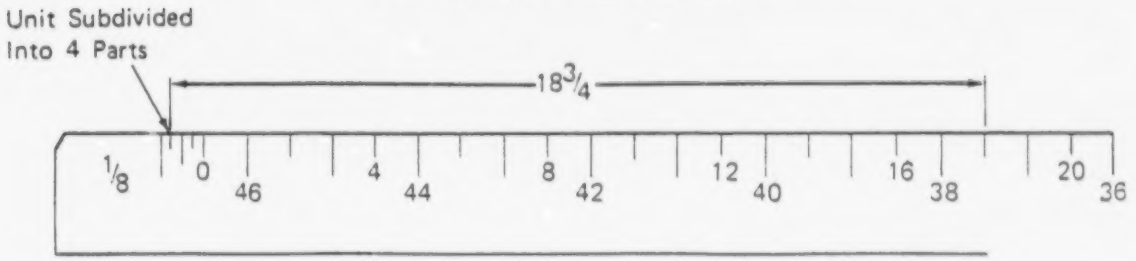


D. 1/8" = 1" **(one-eighth size)**

1. When measuring a given line on a scale ratio of 1/8" = 1", use the scale marked 1/8

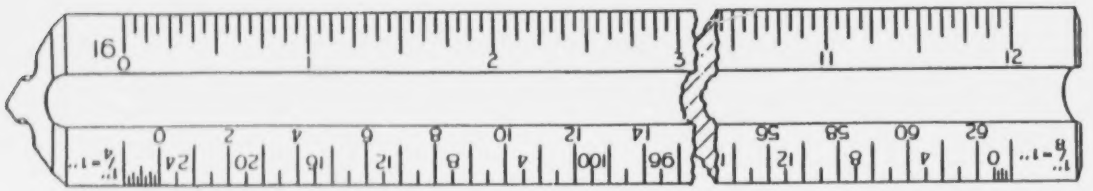
2. The subdivisions to the left of 0 represent one inch compressed to a 1/8" length in 4 units which represent 1/4"

Example: To measure the distance indicated on the scale below, lay the 1/8 scale parallel to the line being measured, then move the scale to the right until it shows only the full inches to the right of 0 (in this case it is 18"); next, read the subdivisions to the left of 0 to determine the inches and fractions of an inch (in this case it is 3/4"), which when added to the full inches will give a reading of 18 3/4"



MECHANICAL ENGINEER'S SCALE

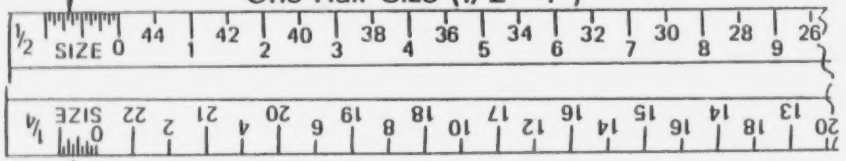
1"=1" Full Scale



One-Eighth Size (1/8" =1")

16 Subdivions in 1 st. Unit

One-Half Size (1/2"=1")



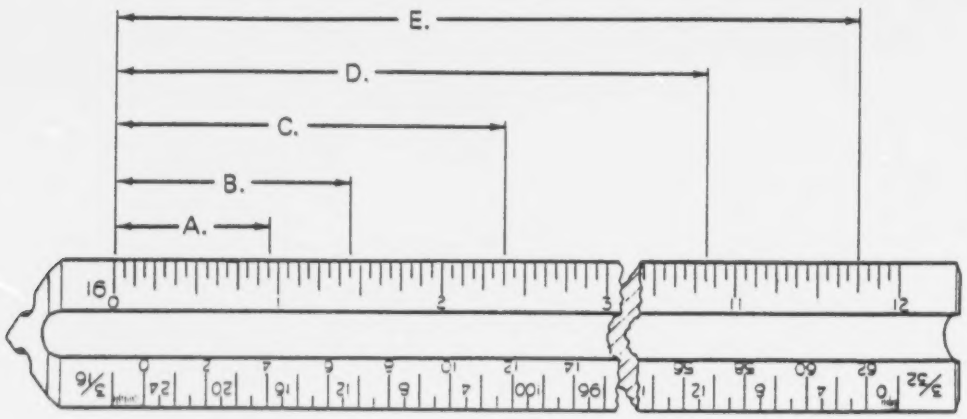
One-Quarter Size (1/4"=1")

8 Subdivions in 1 st. Unit

An alternate form of mechanical engineer's scale is shown at right

READ THE MECHANICAL ENGINEER'S SCALE USING A SCALE RATIO OF 1" = 1"

Directions: Read the measurements shown below at 1" = 1" scale (full size). Read the lengths from 0 at left of the points indicated on the scale. Place the correct measurements in the blanks below the figure.



A. _____

B. _____

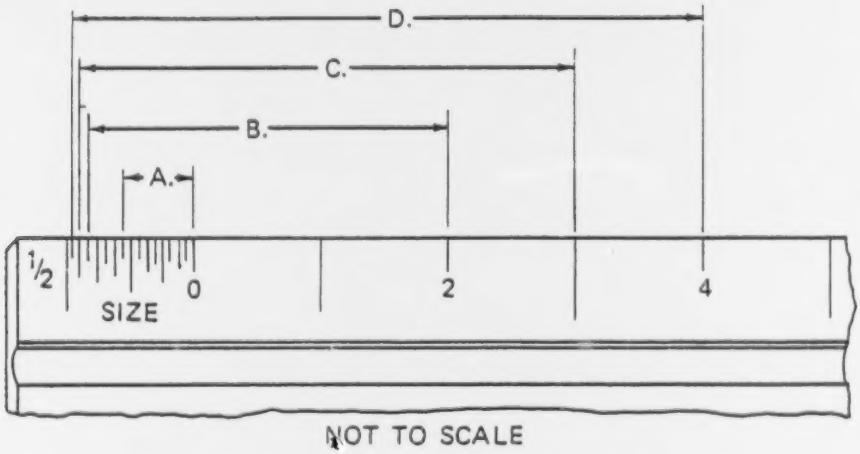
C. _____

D. _____

E. _____

READ THE MECHANICAL ENGINEER'S SCALE USING A SCALE RATIO OF 1/2" = 1"

Directions: Read the measurements shown below at 1/2" = 1" scale (half size). Read the full inch units from 0 to the right and the fractional units to the left. Place the correct measurements in the blanks below the figure.



NOT TO SCALE

A. _____

B. _____

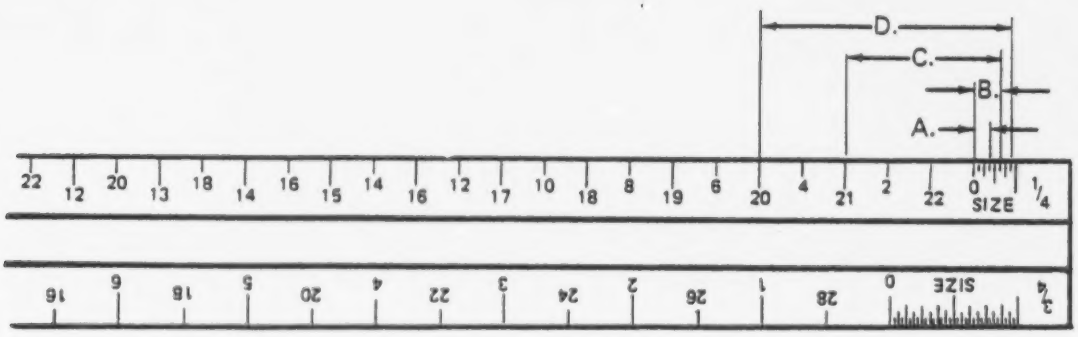
C. _____

D. _____

E. _____

READ THE MECHANICAL ENGINEER'S SCALE USING A SCALE RATIO OF 1/4" = 1"

Directions: Read the measurements shown below at 1/4" = 1" scale (quarter size). Read the full inch units from 0 to the left and the fractional units to the right of 0. Place the correct measurements in the blanks below the figure.



A. _____

B. _____

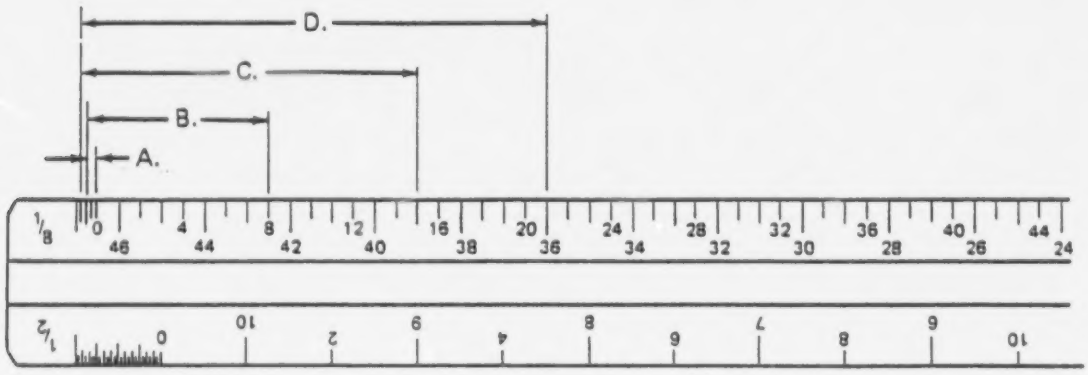
C. _____

D. _____

E. _____

READ THE MECHANICAL ENGINEER'S SCALE USING A SCALE RATIO OF 1/8"=1"

Directions: Read the measurements shown below at 1/8" = 1" scale (one-eighth size). Read the full inch units from 0 to the right and the fractional unit to the left. Place the correct measurements in the blanks below the figure.



A. _____

B. _____

C. _____

D. _____

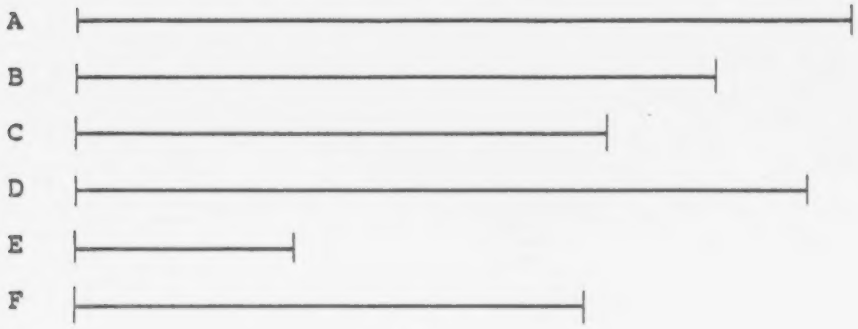
E. _____

MEASURE LINES ACCURATELY WITH VARIOUS SCALE RATIOS ON A MECHANICAL ENGINEER'S SCALE

Directions: Measure the lines A through F to the scale heading each column in the table. Letter the scale readings in the appropriate space in the table.

Example: Measure Line A to the scale 1/2" = 1". A reading of _____ is obtained. This dimension is lettered under the 1/2" = 1" column and opposite the letter A. Use guide lines for 1/32 lettering.

NOTE: Readings must be accurate or they will be considered wrong.



	1" = 1"	1/2" = 1"	1/4" = 1"	1/8" = 1"
A				
B				
C				
D				
E				
F				

ANSWERS TO ASSIGNMENT SHEETS 6.1 - 6.5

AS 6.1

A. 15/16"
B. 1 7/16"
C. 2 3/8"
D. 10 13/16"
E. 11 3/4"

AS 6.2

A. 9/16"
B. 2 13/16"
C. 3 7/8"
D. 4 15/16"

AS 6.3

A. 3/8"
B. 5/8"
C. 3 5/8"
D. 5 7/8"

AS 6.4

A. 1/2"
B. 8 1/2"
C. 15 3/4" or 1'-3 3/4"
D. 21 3/4" or 1'-9 3/4

AS 6.5

	1" = 1"	1/2" = 1"	1/4" = 1"	1/8" = 1"
A	4 15/32"	8 15/16"	17 7/8"	35 3/4"
B	3 11/16"	7 3/8"	14 3/4"	29 1/2"
C	3 1/16"	6 1/8"	12 1/4"	24 1/2"
D	4 7/32"	8 7/16"	16 7/8"	33 3/4"
E	1 1/4"	2 1/2"	5"	10"
F	2 15/16"	5 7/8"	11 3/4"	23 1/2"

MODULE I: DRAFTING FUNDAMENTALS

UNIT 6: MECHANICAL ENGINEER'S SCALE USAGE

UNIT TEST

Select the option which best completes the question.

____ 1. Which of the following statements describes the mechanical engineer's scale?

a. a scale that has one full-size scale and ten reduced-size scales

b. a scale used primarily for drawings of buildings, piping systems and other large structures

c. a scale graduated in units of one inch divided into 10, 20, 30, 40, 50 and 60 parts

d. a scale divided into units representing full size (1" = 1"), half size (1/2" = 1"), quarter size (1/4" = 1") and one-eighth size (1/8" = 1")

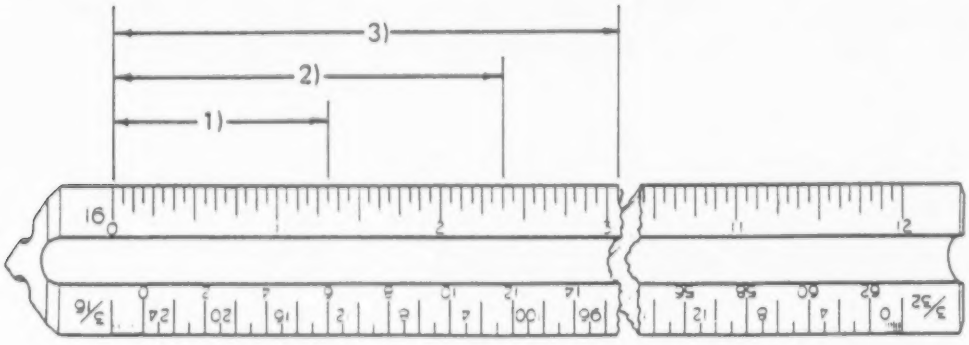
2. **List four scale ratios that are found on a mechanical engineer's scale.**

a. _____ c. _____

b. _____ d. _____

3. **Interpret graduations on the engineer's scale.**

a. 1" = 1"

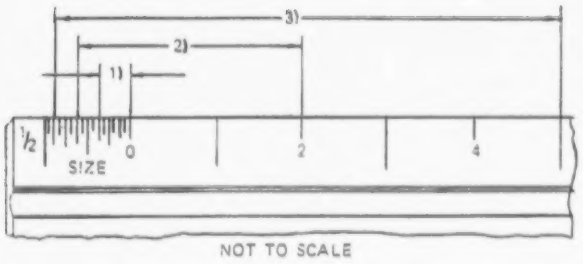


1) _____

2) _____

3) _____

b. 1/2" = 1"

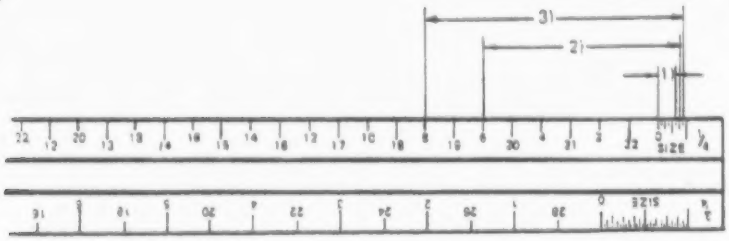


1) _____

2) _____

3) _____

c. 1/4" = 1"

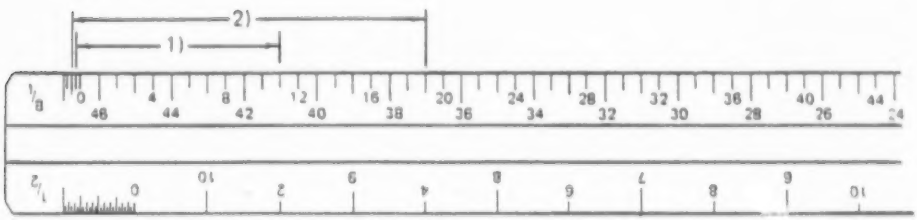


1) _____

2) _____

3) _____

d. 1/8" = 1"



1) _____

2) _____

4. **State the purpose for using a mechanical engineer's scale.**

ANSWERS TO UNIT VI TEST (C-4)

1. d

2. a. 1" = 1"

   b. 1/2" = 1"

   c. 1/4" = 1"

   d. 1/8" = 1"

3. a. 1) 1 5/16"

      2) 2 3/8"

      3) 3 1/16"

   b. 1) 3/8"

      2) 2 5/8"

      3) 5 7/8"

   c. 1) 5/8"

      2) 6 3/4"

      3) 8 7/8"

   d. 1) 11 1/4"

      2) 19 1/2"

4. To provide a standard of reference that is needed when drawing mechanical parts where the dimensions are in inches or fractions.

MODULE: DRAFTING FUNDAMENTALS

UNIT VII: METRIC SCALE USAGE

UNIT OBJECTIVE

After completion of this unit, the student should be able to describe the purpose for using a metric scale and be able to list standard scale ratios to which objects can be drawn with the metric scale. The student should be able to interpret scale graduations and correctly measure lengths with the metric scale. This knowledge will be evidenced by correctly performing the procedures outlined on the assignment sheets and by scoring ____ percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

7.1 Match terms related to metric scale usage with their correct definitions.

7.2 State the purpose for using a metric scale.

7.3 Identify basic shapes of metric scales.

7.4 Select rules for correct scale usage.

7.5 Explain a scale ratio.

7.6 Distinguish between a reduction scale ratio and an enlargement scale ratio.

7.7 Select metric scale ratios commonly used for various drafting applications.

7.8 List commonly used scale ratios found on triangular metric scales.

7.9 Interpret scale graduations on a full divided 1:1, 1:100 metric scale.

7.10 Interpret metric scale ratios commonly used for machine drawings.

7.11 Interpret metric scale ratios commonly used for architectural construction details.

7.12 Demonstrate the ability to:

- a. Read the metric scale at the scale ratio of 1:1.
- b. Read the metric scale at the scale ratio of 1:2.
- c. Read the metric scale at the scale ratio of 1:5.
- d. Read the metric scale at the scale ratio 1:25.
- e. Read the metric scale at the scale ratio 1:33 1/3.
- f. Read the metric scale at the scale ratio 1:75.
- g. Measure lines accurately with various scale ratios found on a metric scale.

MODULE: DRAFTING FUNDAMENTALS

UNIT VII: METRIC SCALE USAGE

CONTENTS OF THIS UNIT

A. Objective sheet

B. References

C. Notes to the instructor

D. Lesson plans

1. Lesson 1: USING THE METRIC SCALE

   a. Information outline

   b. Transparency masters

      TM 7.1: Metric Scales (Triangular)
      TM 7.2: Frequently Used Metric Reduction Scales
      TM 7.3: Frequently Used Metric Enlargement Scales

   c. Assignment Sheets

      AS 7.1: Read the Metric Scale at the Scale Ratio of 1:1
      AS 7.2: Read the Metric Scale at the Scale Ratio of 1:2
      AS 7.3: Read the Metric Scale at the Scale Ratio of 1:5
      AS 7.4: Read the Metric Scale at the Scale Ratio of 1:25
      AS 7.5: Read the Metric Scale at the Scale Ratio of 1:33 1/3
      AS 7.6: Read the Metric Scale at the Scale Ratio of 1:75
      AS 7.7: Measure Lines Accurately with Various Scale Ratios Found on a Metric Scale

   d. Answers to assignment sheets

E. Unit test

F. Answers to unit test

REFERENCES

1. Brown, Walter C. Drafting for Industry. South Holland, Ill. 60473: The Goodheart-Wilcox Company, Inc., 1974.

2. Davis, Ronald, Bill Hill, and Bruce Yancey. Basic Drafting: Book One. Stillwater Okla., 74074: Mid-America Vocational Curriculum Consortium, Inc., 1981.

3. Dygdon, John Thomas and Henry Cecil Spencer. Basic Technical Drawing. New York 10022: Macmillan Publishing Co., Inc., 1968.

4. Gerevas, Lawrence E. Drafting Technology Problems, 2nd ed. Napa, Calif: Bobbs-Merrill Educational Publishing, 1981.

5. Giesecke, Frederick E., et al. Technical Drawing. New York 10022: Macmillan Publishing Co., Inc., 1980.

6. Jensen, Cecil and Jay Helsel. Engineering Drawing and Design. New York: Gregg Division/McGraw-Hill Book Company, 1979.

7. Spence, William P. Drafting Technology and Practice. Revised ed. Pittsburgh, Kan. 66762: Bennett & McKnight Publishing Company, 1980.

8. Wallach, Paul Ross. Drafting Problems Book. Glencoe Publishing Company, 1988.

NOTES TO THE INSTRUCTOR

A. Suggested approaches to teaching this unit

1. Have students practice measuring objects in the classroom. Use metric comparison charts in discussing the use of metric scales.

MODULE: CONSTRUCTION TECHNIQUES

UNIT VI: METRIC SCALE USAGE

LESSON 1: USING THE METRIC SCALE

I. Terms and definitions

A. Centimeter (cm)--1/100 of a meter

B. Decimeter (dm)--1/10 of a meter

C. Meter (m)--the metric system standard for linear measurement

D. Metric system--a decimal system of weights and measures based on the meter and the kilogram

E. Millimeter (mm)--1/1000 of a meter

NOTE: This is the primary unit of measurement for engineering

F. Scale ratio--a relationship between dimensional values used to reduce or enlarge the size of an object so that it can be drawn proportionally

G. SI--the modern form of the metric system "The International System of Units"

II. Purpose for using a metric scale--to provide a standard of reference for constructing a drawing either in its actual size or larger or smaller than full size

III. Explanation of a scale ratio--a ratio between the actual dimension and another dimension that will be used to represent the actual size

NOTE: The ratio 1:1 would indicate 1 millimeter = 1 millimeter while 1:10 would indicate 1 millimeter = 10 millimeters.

IV. Reduction and enlargement scale ratios (TMs 7.2 and 7.3)

A. Frequently used reduction scales are 1:2, 1:3, 1:5, and 1:10

NOTE: 1:2 means 1 mm = 2 mm, 1:5 means 1 mm = 5 mm

B. Frequently used enlarging scale ratios are 2:1 and 5:1

NOTE: It is always recommended to use full-size (1:1) whenever possible

V. Metric scale ratios commonly used for various drafting applications

NOTE: See graph on next page

Metric mm:mm	Application
1:1 1:2 1:3 1:5 1:10	Machine drawings
1:20 1:25 1:33 1/3	Architectural construction details
1:75 1:100 1:200	Architectural plans and elevations Architectural plot plans
1:500 1:1250 1:2500 1:10,000 1:50,000	Maps (civil drawings)

VI. Commonly used scale ratios found on triangular metric scales (TM 7.1)

A. 1:1
B. 1:2
C. 1:5
D. 1:25
E. 1:33 1/3
F. 1:75

VII. How to interpret scale graduations found on a full-divided 1:1, 1:100 metric scale

A. Many metric scales have multiple scale ratios along one edge to allow for a variety of scales to be used from a single instrument

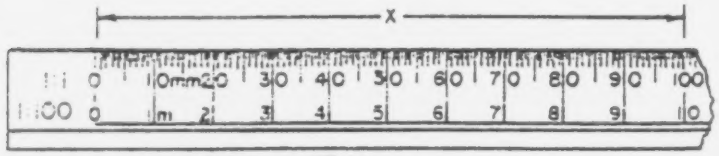
B. The 1:1 (full size) scale ratio is the basic scale used; each subdivision is actually 1 mm in width with the calibrations numbered at 10 mm intervals

VIII. Metric scale ratios commonly used for machine drawings

A. 1:1 ratio (full size) has scale subdivisions 1 mm in width with calibrations numbered in 10 mm increments

NOTE: Some scales have subdivisions in 1/2 mm, and these should not be confused with the standard 1 mm subdivisions

1. Measurements are made by reading directly from the 1:1 scale ratio in millimeters (Figure 1)



x=100 mm AT 1:1
x=1,000 mm AT 1:10
x=10,000 mm AT 1:100

2. When read 1:10, this scale ratio is used for machine drawings, when read 1:100, this scale ratio is used for architectural drawings, and when read 1:1000, this scale ratio is used for map drawings

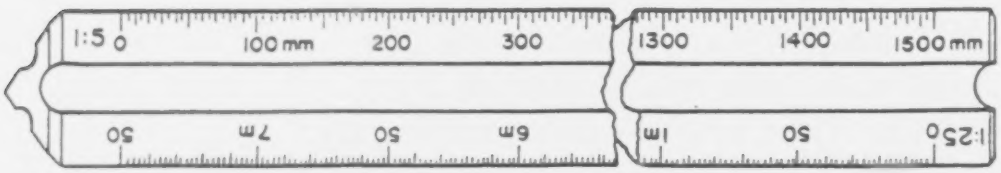
B. 1:2 ratio (half size) has scale subdivisions representing 2 mm of width with calibrations numbered in 20 mm increments

1. Measurements are made by reading directly from the 1:2 scale ratio in millimeters (Figure 1)

2. When read 1:20, this scale ratio is used for machine drawings, when read 1:200, this scale ratio is used for architectural drawings, and when read 1:2000, this scale ratio is used for map drawing

C. 1:5 ratio (one-fifth size) has scale subdivisions representing 5 mm of width with calibrations numbered in 100 mm increments

1. Measurements are made by reading directly from the 1:5 scale ratio in millimeters (Figure 2)

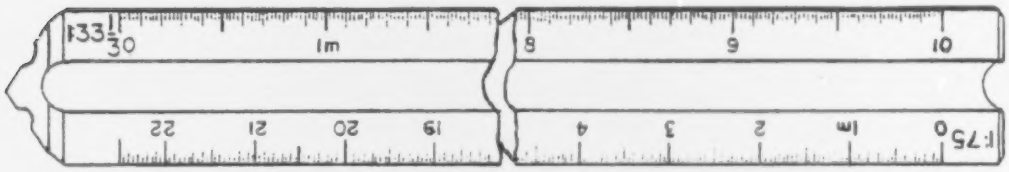


2. When read 1:50, this scale ratio is used for machine drawings, when read 1:500, this scale ratio is used for architectural drawings, and when read 1:5000, this scale is used for map drawings

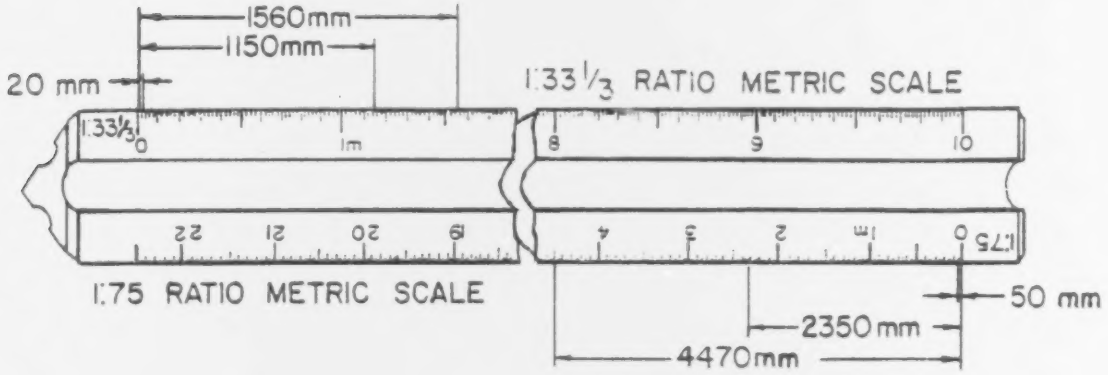
XI. Metric scale ratios commonly used for architectural construction details

A. 1:25 ratio has subdivisions representing 20 mm of width with calibrations numbered in 500 mm increments, and measurements are made by reading directly from the 1:25 scale in meters and millimeters (Figure 3)

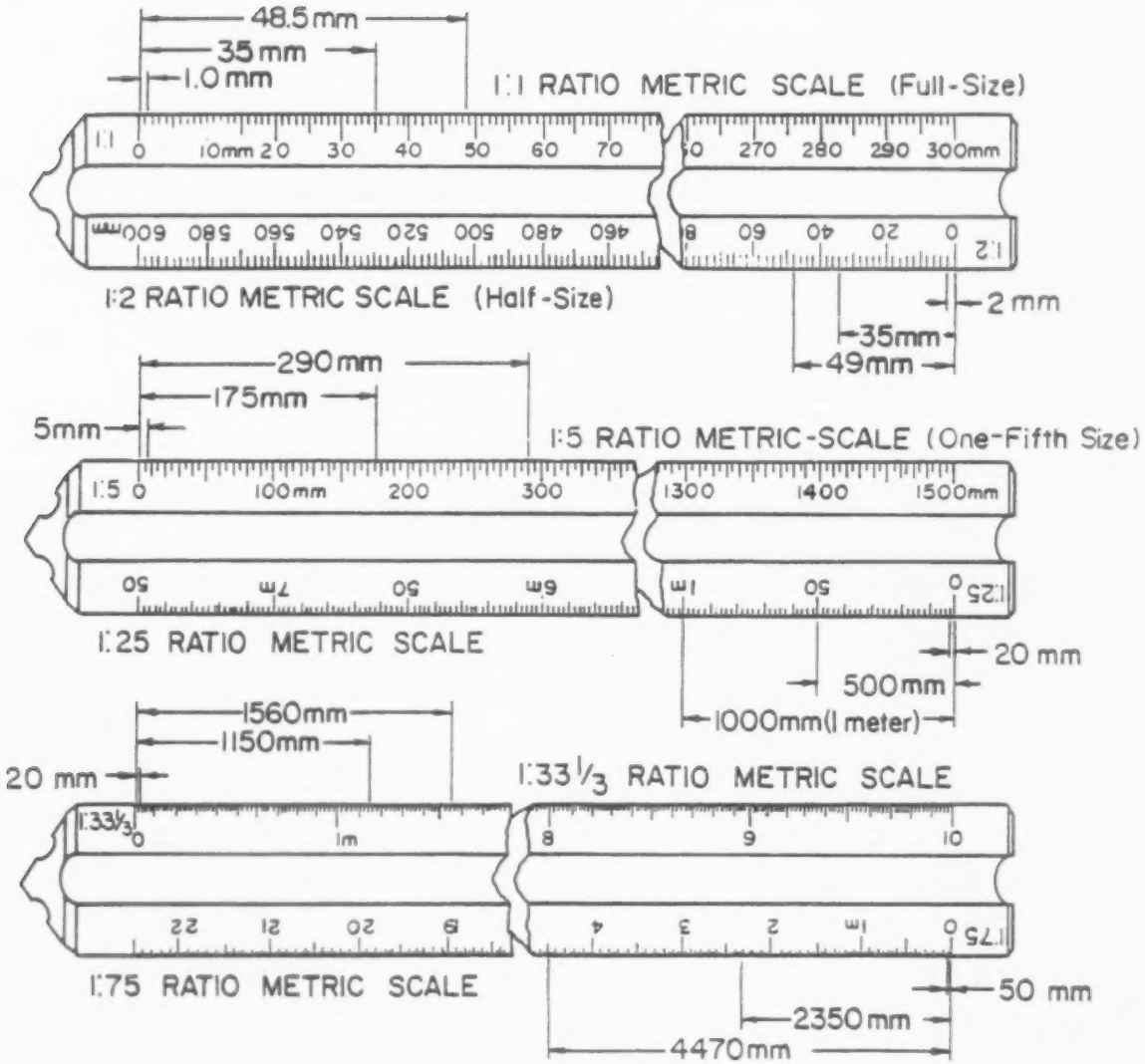
B. 1:33 1/3 ratio has subdivisions representing 20 mm of width with calibrations numbered in 1000 mm increments, and measurements are made by reading directly from the 1:33 1/3 scale in millimeters (Figure 3)



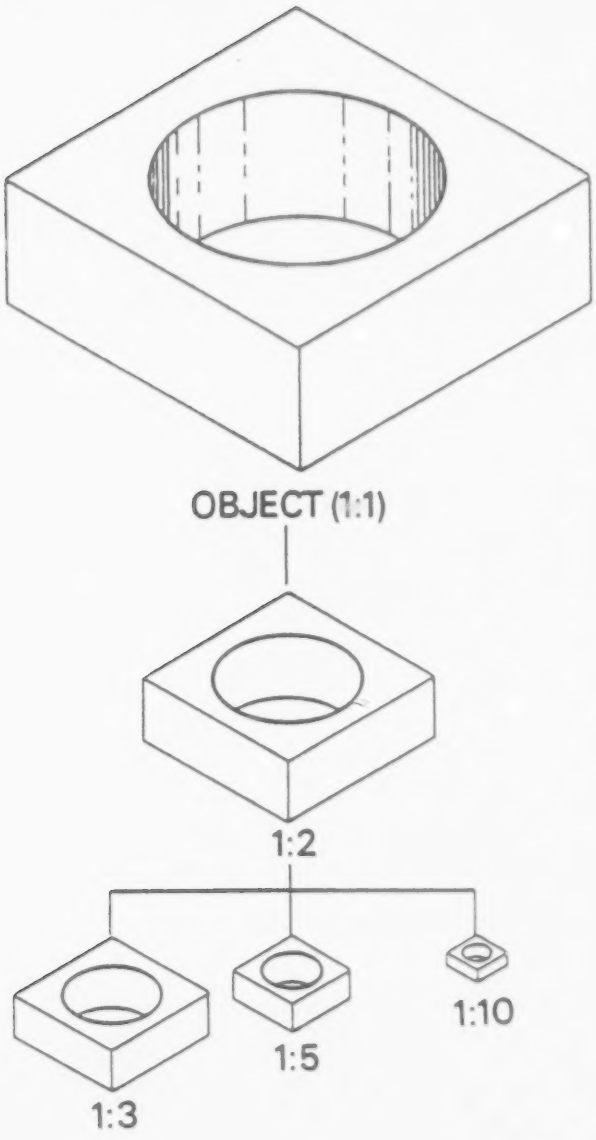
C. 1:75 ratio has subdivisions representing 50 mm of width with calibrations numbered in 1000 mm (1 m) increments, and measurements are made by reading directly from the 1:75 scale in millimeters (Figure 4)



METRIC SCALES (TRIANGULAR)

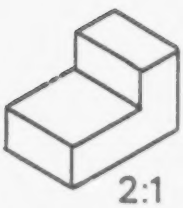


FREQUENTLY USED METRIC REDUCTION SCALES

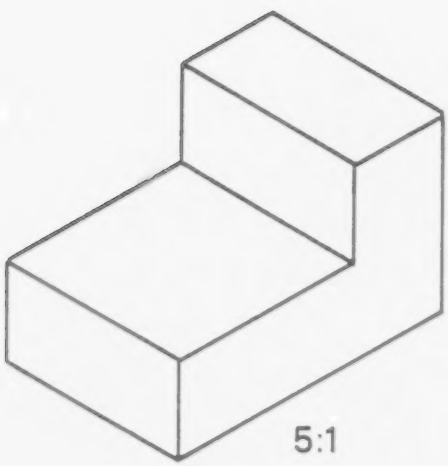


FREQUENTLY USED METRIC ENLARGEMENT SCALES

OBJECT (1:1)



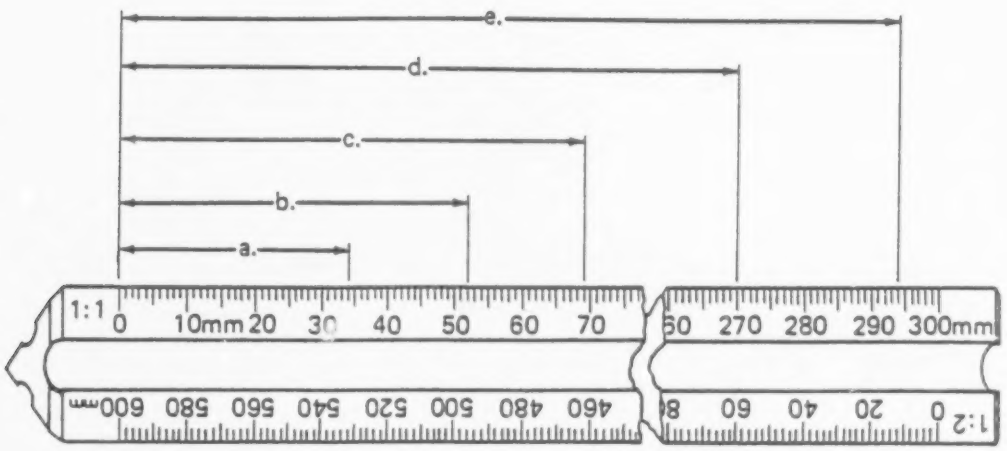
2:1



5:1

READ THE METRIC SCALE AT THE SCALE RATIO OF 1:1

Directions: Read the measurements shown below at 1:1 scale ratio (full size). Read the lengths from 0 at the left side to the point indicated on the scale. Place the correct measurements in the blanks below the figure.



a. _____

b. _____

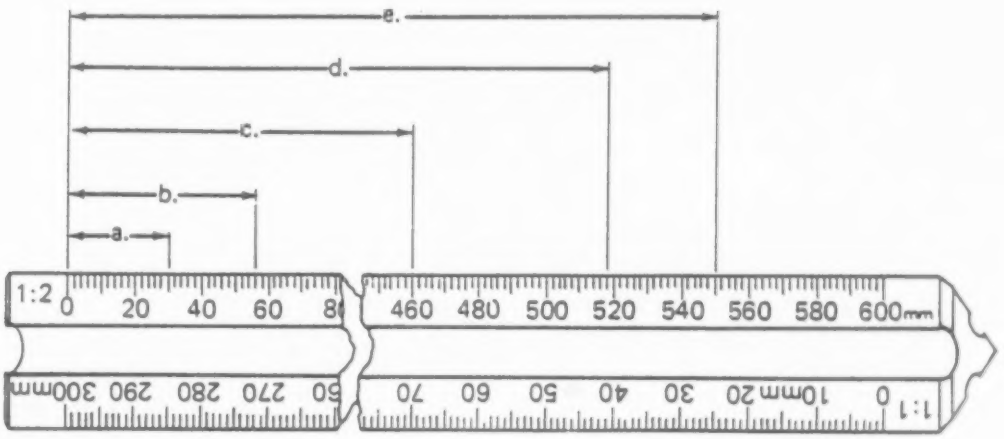
c. _____

d. _____

e. _____

READ THE METRIC SCALE AT THE SCALE RATIO OF 1:2

Directions: Read the measurements shown below at 1:2 scale ratio (half size). Read the lengths from 0 at the left side to the point indicated on the scale. Place the correct measurements in the blanks below the figure.



a. _____

b. _____

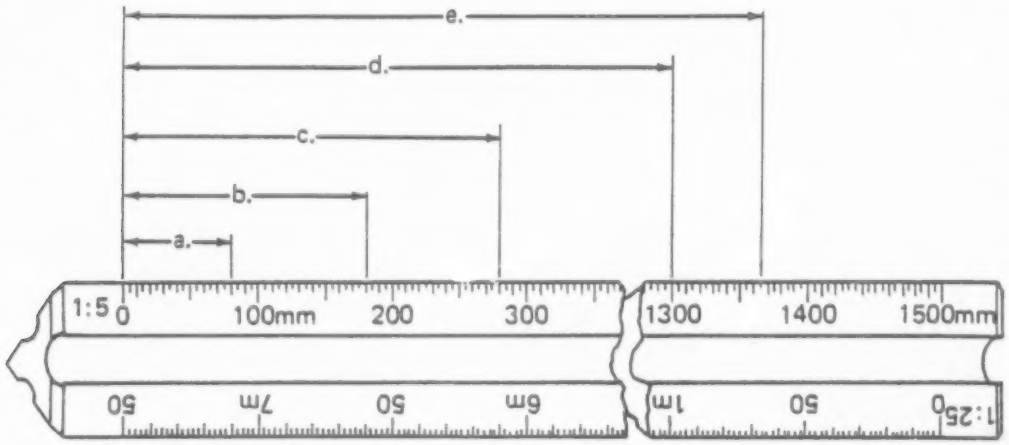
c. _____

d. _____

e. _____

READ THE METRIC SCALE AT THE SCALE RATIO OF 1:5

Directions: Read the measurements shown below at 1:5 scale ratio. Read the lengths from 0 at the left side to the point indicated on the scale. Place the correct measurements in the blanks below the figure.



a. _____

b. _____

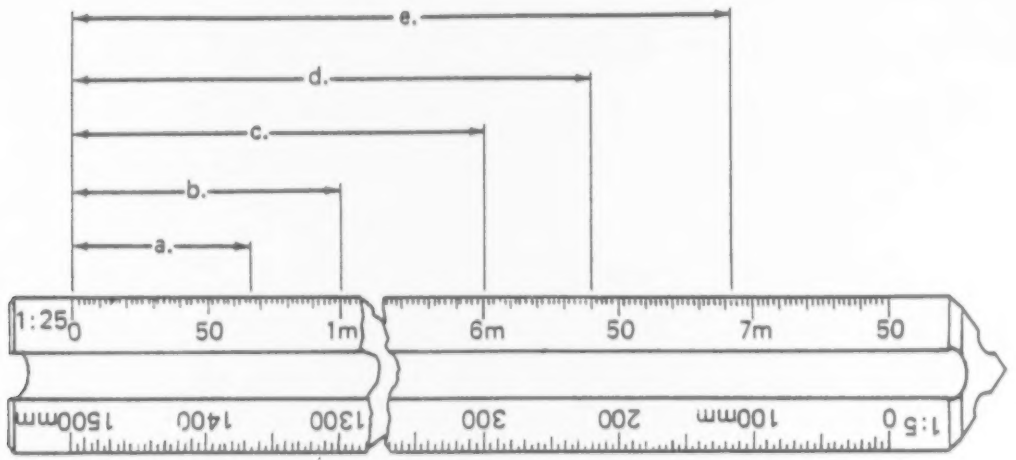
c. _____

d. _____

e. _____

READ THE METRIC SCALE AT THE SCALE RATIO OF 1:25

Directions: Read the measurements shown below at 1:25 ratio. Read the lengths from 0 at the left to the point indicated on the scale. Place the correct measurements in the blanks below the figure.



a. _____

b. _____

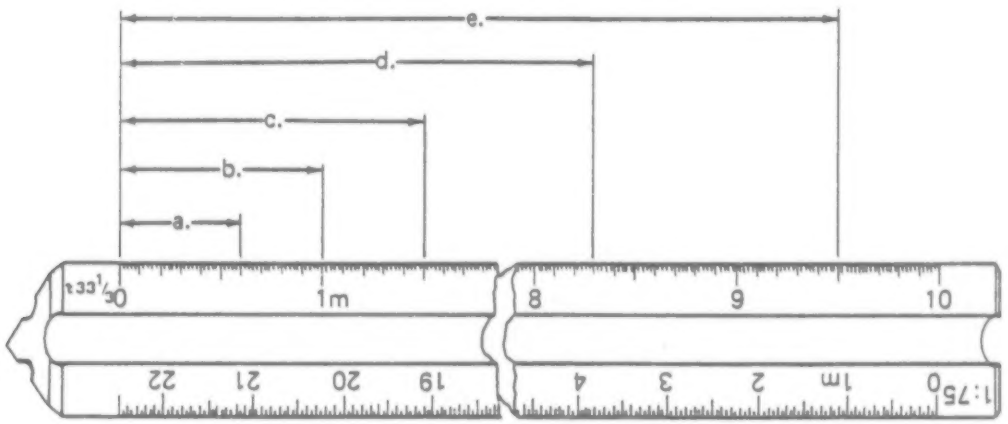
c. _____

d. _____

e. _____

READ THE METRIC SCALE AT THE SCALE RATIO OF 1:33 1/3

Directions: Read the measurements shown below at 1:33 1/3 ratio. Read the lengths from 0 at the left end to the point indicated on the scale. Place the correct measurements in the blanks below the figure.



a. _____

b. _____

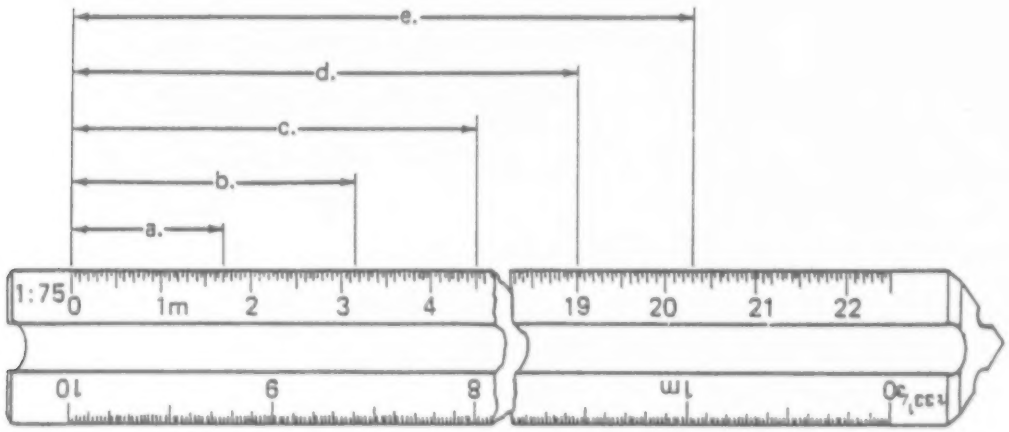
c. _____

d. _____

e. _____

READ THE METRIC SCALE AT THE SCALE RATIO OF 1:75

Directions: Read the measurements shown below at 1:75 scale ratio. Read the lengths from 0 at the left end to the point indicated on the scale. Place the correct measurements in the blanks below the figure.



a. _____

b. _____

c. _____

d. _____

e. _____

MEASURE LINES ACCURATELY WITH VARIOUS SCALE RATIOS FOUND ON A METRIC SCALE

Directions: Measure the lines A through F to the scale heading each column in the table. Letter the scale readings in the appropriate space in the table. Use guidelines for 1/8 lettering.

Example: Measure line A to the scale ratio 1:2. When the reading is obtained, dimension should be lettered under the 1:2 column and opposite the letter A.

A

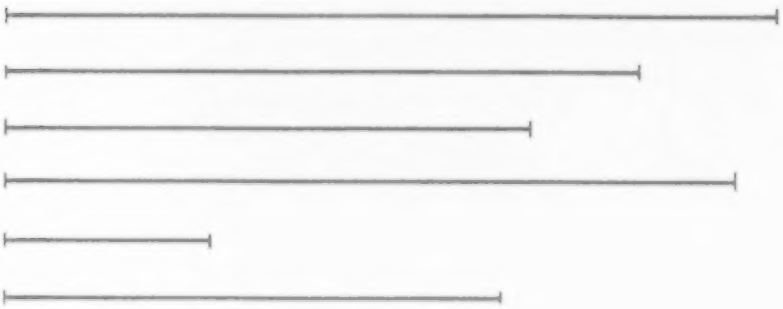
B

C

D

E

F



	1:1	1:2	1:5	1:25	1:33 1/3	1:1000
A						
B						
C						
D						
E						
F						

ANSWERS TO ASSIGNMENT SHEETS 1.1 - 1.7

AS 1.1

a. 34 mm
b. 52 mm
c. 69 mm
d. 270 mm
e. 294 mm

AS 1.2

a. 30 mm
b. 56 mm
c. 460 mm
d. 518 mm
e. 550 mm

AS 1.3

a. 80 mm
b. 180 mm
c. 280 mm
d. 1300 mm
e. 1365 mm

AS 1.4

a. 660 mm
b. 1 m
c. 6 m
d. 6 m-400 mm or 6400 mm
e. 6 m-920 mm or 6920 mm

AS 1.5

a. 600 mm
b. 1000 mm or 1 m
c. 1 m-500 mm or 1500 mm
d. 8 m-300 mm or 8300 mm
e. 9 m-500 mm or 9500 mm

AS 1.6

a. 1 m-700 mm or 1700 mm
b. 3 m-150 mm or 3150 mm
c. 4 m-500 mm or 4500 mm
d. 19 m or 19,000 mm
e. 20 m-300 mm, or 20,300

AS 1.7

	1:1	1:2	1:5	1:25	1:33 1/3	1:1000
A	113 mm	227 mm	566 mm	282.5 mm	378 mm	11,300 mm
B	93 mm	186 mm	466 mm	233 mm	310 mm	9,300 mm
C	77 mm	154 mm	386 mm	193 mm	257 mm	7,700 mm
D	107 mm	214 mm	536 mm	268 mm	358 mm	10,700 mm
E	30 mm	60 mm	150 mm	75 mm	100 mm	3,000 mm
F	73 mm	146 mm	364 mm	192 mm	244 mm	7,300 mm

MODULE: DRAFTING FUNDAMENTALS

UNIT VII: METRIC SCALE USAGE

UNIT TEST

Match each term on the right with its correct definition on the left.

____	1.	A relationship between dimensional values used to reduce or enlarge the size of an object so that it can be drawn proportionally	a.	Meter
____	2.	A decimal system of weights and measures based on the meter and the kilogram	b.	Decimeter (dm)
____	3.	The metric system standard for linear measurement	c.	SI
____	4.	The modern form of the metric system "The International System of Units"	d.	Scale ratio
____	5.	1/1000 of a meter	e.	Millimeter (mm)
____	6.	1/100 of a meter	ab.	Metric system
____	7.	1/10 of a meter	ac.	Centimeter (cm)

Distinguish between a reduction scale ratio and an enlargement scale ratio by placing an "a" by each example of a reduction scale ratio and a "b" by each example of an enlargement scale ratio.

____ 8. 1:2

____ 9. 5:1

____ 10. 1:5

____ 11. 2:1

____ 12. 1:33 1/3

____ 13. 1:25

Select metric scale ratios commonly used for various drafting applications by placing an "a" by those ratios commonly used for machine drawings, a "b" by those ratios commonly used for architectural plans, details and plot plans, and a "c" by those ratios commonly used for maps.

____	14.	1:1	a = machine drawing ratios
____	15.	1:50,000	b = architectural plans, details and plot plans ratios
____	16.	1:3	c = map ratios
____	17.	1:500	
____	18.	1:10	
____	19.	1:2,500	
____	20.	1:75	
____	21.	1:33 1/3	
____	22.	1:25	
____	23.	1:100	
____	24.	1:200	
____	25.	1:5	
____	26.	1:20	
____	27.	1:10,000	
____	28.	1:2	

29. **Explain a scale reduction ratio.**

_____

_____

_____

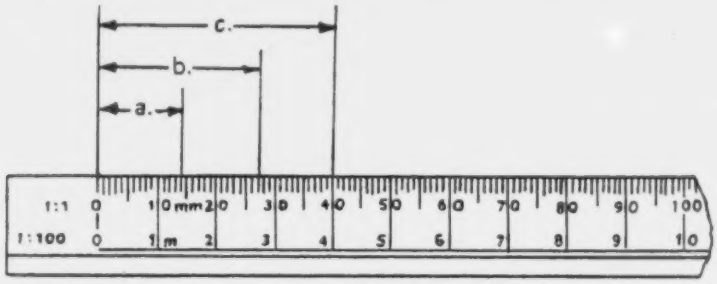
30. **List commonly used scale ratios found on metric scales.**

a. _____ d. _____

b. _____ e. _____

c. _____ f. _____

31. **Interpret scale graduations found on a full divided 1:1, 1:10 metric scale.**



At 1:1 ratio

a. _____

b. _____

c. _____

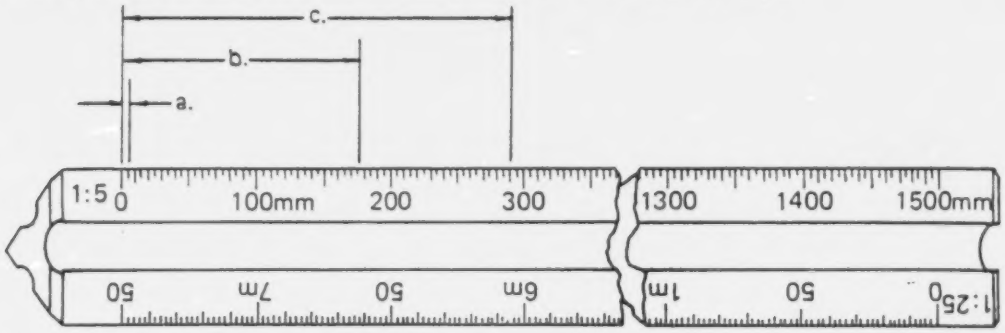
At 1:100 ratio

a. _____

b. _____

c. _____

32. **Interpret metric scale ratios commonly used for machine drawings.**

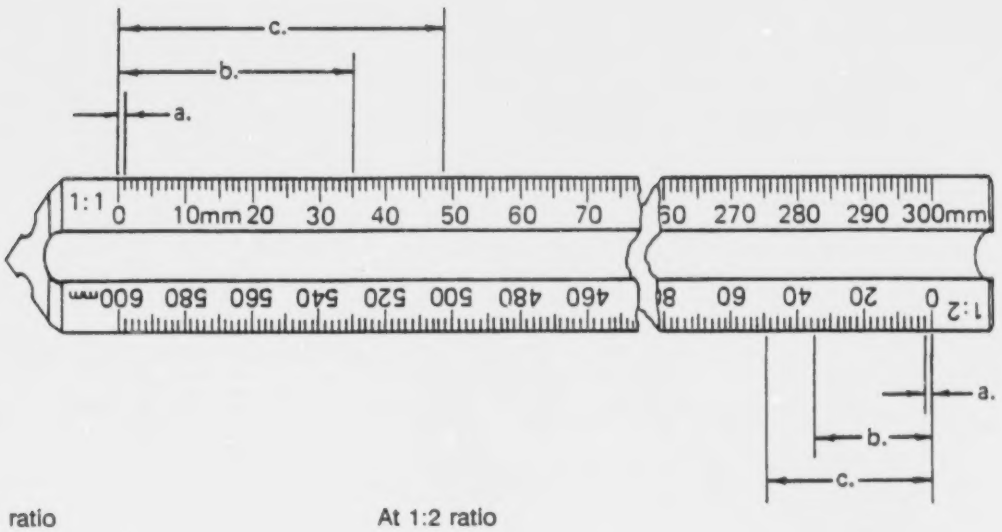


At 1:5

a. _____

b. _____

c. _____



At 1:1 ratio

a. _____

b. _____

c. _____

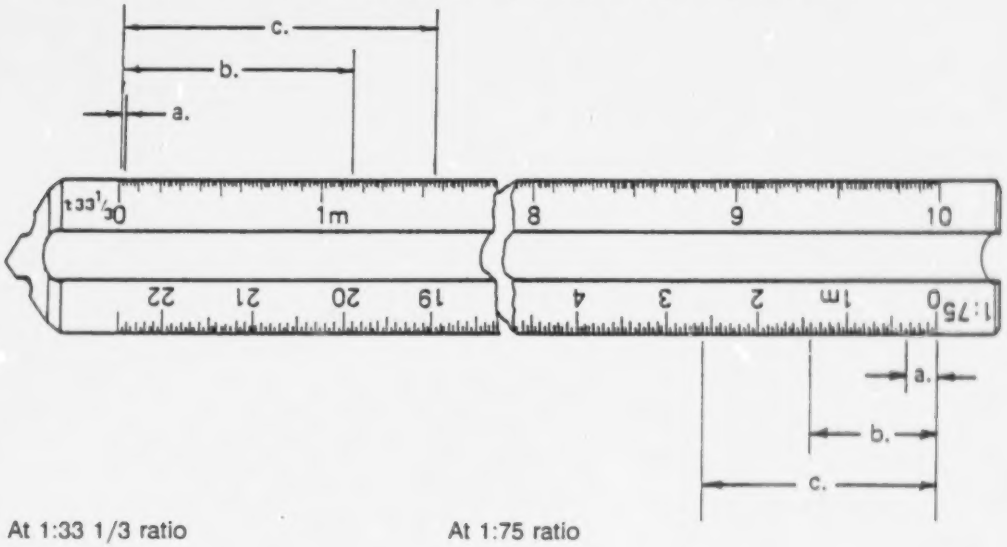
At 1:2 ratio

a. _____

b. _____

c. _____

33. **Interpret scale ratios commonly used for architectural construction details.**



At 1:33 1/3 ratio

a. _____

b. _____

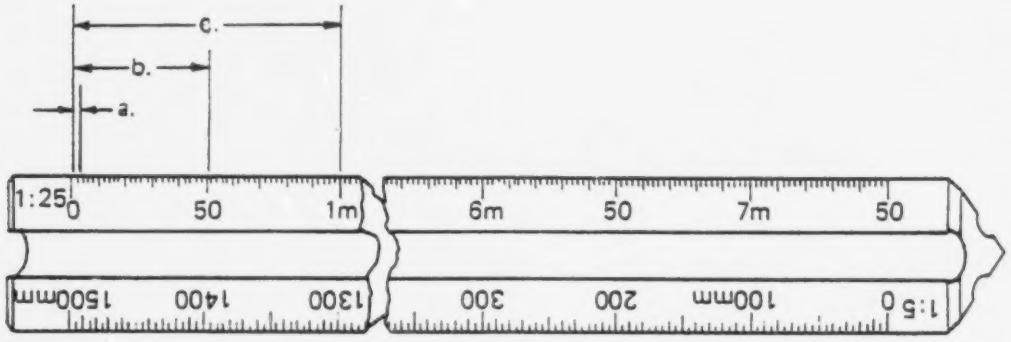
c. _____

At 1:75 ratio

a. _____

b. _____

c. _____



At 1:25 ratio

a. _____

b. _____

c. _____

ANSWERS TO UNIT VII TEST (C-4)

1. d
2. ab
3. a
4. c
5. e
6. ac
7. b
8. a
9. b
10. a
11. b
12. a
13. a
14. a
15. c
16. a
17. c
18. a
19. c
20. b
21. b
22. b
23. b
24. b
25. a
26. b
27. c
28. a
29. Explanation should include: A ratio between the actual dimension and another dimension that will be used to represent the actual size.
30. The following in any order:
    a. 1:1
    b. 1:2
    c. 1:5
    d. 1:25
    e. 1:33 1/3
    f. 1:75
31. 1:1 Ratio
    a. 14 mm
    b. 27 mm
    c. 40 mm
    1:100 Ratio
    a. 1.4 m
    b. 2.7 m
    c. 4.0 m
32. At 1:5 Ratio
    a. 5 mm
    b. 175 mm
    c. 290 mm
    At 1:1 Ratio
    a. 1 mm
    b. 35 mm
    c. 48.5 mm
    At 1:2 Ratio
    a. 2 mm
    b. 35 mm
    c. 49 mm
33. At 1:25 Ratio
    a. 20 mm
    b. 500 mm
    c. 1000 mm
    At 1:33 1/3 Ratio
    a. 20 mm
    b. 1150 mm
    c. 1560 mm
    At 1:75 Ratio
    a. 350 mm
    b. 1400 mm
    c. 2600 mm

MODULE: DRAFTING FUNDAMENTALS

UNIT VIII: GRAPHIC REPRODUCTION

UNIT OBJECTIVE

After completion of this unit, the student should be able to identify basic reproduction terms. The student should also be able to operate reproduction equipment. This knowledge will be evidenced by correctly performing the procedures outlined on the assignment sheet and job sheet, and by scoring ____ percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

8.1 Match terms related to reproduction with their correct definitions.

8.2 Demonstrate the ability to:

a. Make blueline or blackline prints

b. Operate a blueline machine

MODULE: DRAFTING FUNDAMENTALS

UNIT VIII: GRAPHIC REPRODUCTION

CONTENTS OF THIS UNIT

A. Objective sheets

B. References

C. Notes to the Instructor

D. Lesson plans

1. Lesson 1: REPRODUCTION

   a. Information outline

   b. Transparency master

      TM 8.1: Dry print process

   c. Assignment sheet

      AS 8.1: Make blueline or blackline prints

   d. Job sheet

      JS 8.1: Operate a blueline machine

E. Unit test

F. Answers to unit test

REFERENCES

1. Brown, Walter C. Drafting for Industry. South Holland, Ill. 60473: Goodheart-Wilcox Co., Inc., 1974.

2. Davis, Ronald, Bill Hill, and Bruce Yancey. Basic Drafting Book One and Book Two. Stillwater, Okla. 74074: Mid-America Vocational Curriculum Consortium, Inc., 1981.

3. Dygdon, John Thomas and Henry Cecil Spencer. Basic Technical Drawing. New York 10022: Macmillan Publishing Co., Inc., 1968.

4. Giesecke, Frederick E., et al. Technical Drawing. New York 10022: Macmillan Publishing Co., Inc., 1980.

5. Jensen, Cecil and Jay Helsel. Engineering Drawing and Design. New York: Gregg Division/McGraw-Hill Book Co., 1979.

6. Spence, William P. Drafting Technology and Practice. Peoria, Ill. 66762: Bennett and McKnight Publishing Co., 1980.

7. Vocational Curriculum Development and Research Center. Basic Drafting. Nagadoches, La. 71457: State of Louisiana Vocational Curriculum Development and Research Center, revised 1979.

NOTES TO THE INSTRUCTOR

A. Suggested approaches to teaching this unit

1. Discuss with the class the safety precautions required when using chemicals in various reproduction processes.

2. Have examples available of materials reproduced by methods other than blue-printing or the diazo processes such as Thermo-Fax or Verifax.

3. Demonstrate how to operate a print machine.

4. Demonstrate how to clean a print machine.

5. Discuss other types of reproduction methods.

6. Demonstrate the use of reproduction equipment.

MODULE: DRAFTING FUNDAMENTALS

UNIT VIII: GRAPHIC REPRODUCTION

LESSON 1: REPRODUCTION

I. Terms and definitions (TM 8.1)

A. Blueline/Blackline--print made by placing a master or an original in contact with light-sensitive material while exposure is being made

B. Blueprint process--A wet process of drawing reproduction using light, water, and chemicals

NOTE: Basically a photographic process, the original drawing serves as the negative

C. Density--The darkness of an image (linework or lettering) area

D. Developer--chemical agent used for treating an exposed light-sensitive material to make the image visible to the eye

E. Drawing reproduction--making copies from completed drawings

F. Electrostatic--reproduction of a drawing or print, similar to a photocopy

G. Eradicator--chemical solution containing acid designed to bleach out unwanted portions of a print

H. Exposure--time period that light of a given intensity has been allowed to act on light-sensitive materials

I. Fading--loss in density of an image

J. Intermediate--the translucent reproduction made on vellum, cloth, or foil made from an original drawing and used in place of the original for making other prints

NOTE: Sometimes the original is placed on the intermediate paper upside down so the drafter can draw on the side of the paper away from the dye lines. A typical use of copies occurs in architectural work when several copies are made of the basic floor plan of a building; the copies are then used for framing, plumbing, heating, ventilating and air conditioning, electrical, and reflected ceiling work

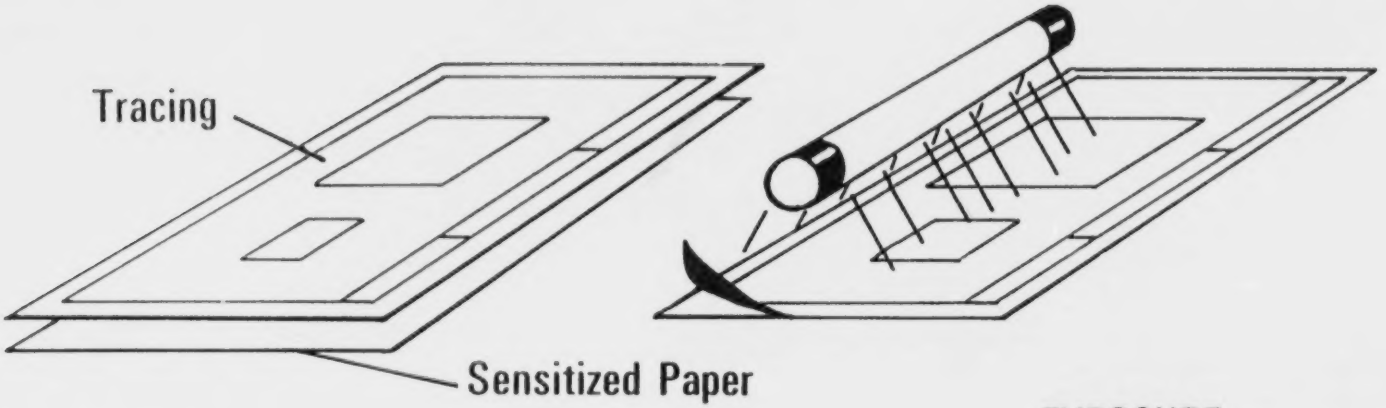
K. Master--any original to be duplicated

L. Printing speed--the rate of speed at which light-sensitive material is exposed, normally expressed in feet per minute of printer operation.

M. Sepia--a print that can be corrected and used as an original for a final reproduction

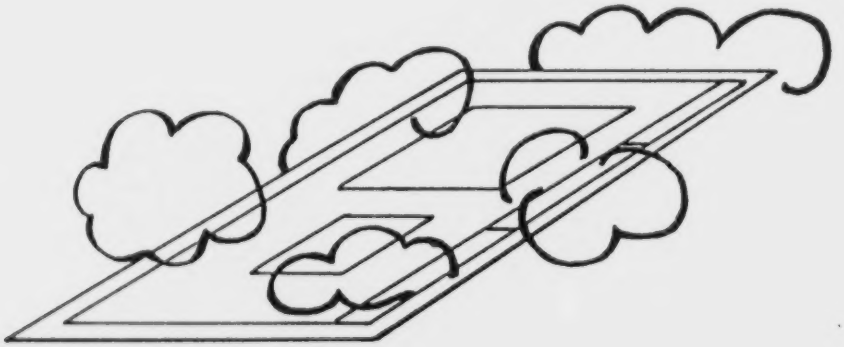
N. Shelf-life--time period before deterioration renders a sensitized material unusable

DRY PRINT PROCESS



CONTACT

EXPOSURE



DEVELOPING WITH AMMONIA VAPORS

MAKE BLUELINE OR BLACKLINE PRINTS

Directions: Make blueline or blackline prints of several drawings done to this date using either a diazo dry process machine or a diazo wet process machine.

NOTE: Instructor may wish to have some drawings reproduced on intermediates such as sepia or foil.

OPERATE A BLUELINE MACHINE

I. Tools and equipment

A. Machine as selected by instructor

B. Safety gear as specified by instructor

NOTE: Before doing any of the following remove all rings, loose jewelry, and, if necessary, tie back hair.

II. Procedure

A. Start up according to manufacturer's specifications

B. Make blueline

C. Shut down according to manufacturer's specifications

NOTE: Ask instructor to verify how the machine in the drafting department works.

MODULE: DRAFTING FUNDAMENTALS

UNIT VIII: GRAPHIC REPRODUCTION

UNIT TEST

Match the terms on the right with their correct definitions on the left.

____ 1.	Chemical solution containing acid designed to bleach out unwanted portions of a print	a.	Fading
____ 2.	Chemical agent used for treating an exposed light-sensitive material to make the image visible to the eye	b.	Eradicator
____ 3.	The rate of speed at which light-sensitive material is exposed, normally expressed in feet per minute of printer operation	c.	Density
____ 4.	The darkness of an image area	d.	Drawing reproduction
____ 5.	Print made by placing a master or an original in contact with light-sensitive material while exposure is being made	e.	Blueline/ Blackline
____ 6.	Time period before deterioration renders a sensitized material unusable	ab.	Developer
____ 7.	The translucent reproduction made on vellum, cloth, or foil made from an original drawing and used in place of the original for making other prints	ac.	Exposure
____ 8.	Making copies from completed drawings	ad.	Master
____ 9.	Any original to be duplicated	ae.	Blueprint process
____ 10.	Loss in density of an image	bc.	Printing speed
____ 11.	Time period that light of a given intensity has been allowed to act on light-sensitive materials	bd.	Shelf life
____ 12.	A wet process of drawing reproduction using light, water and chemicals	be.	Intermediate

ANSWERS TO UNIT VIII TEST

1. b (B3)
2. ab (B3)
3. bc (B3)
4. c (B3)
5. e (B3)
6. bd (B3)
7. be (B3)
8. d (B3)
9. ad (B3)
10. a (B3)
11. ac (B3)
12. ae (B3)

MODULE: DRAFTING FUNDAMENTALS

UNIT IX: MAJOR DRAFTING EQUIPMENT

UNIT OBJECTIVE

After completion of this unit, the student should be able to operate a parallel bar and an adjustable triangle. The student should also be able to make adjustments to an elbow drafting machine and a V-track drafting machine. This knowledge will be evidenced by correctly performing the procedures outlined in the assignment and job sheets and by scoring _____ percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

9.1 Match terms related to major equipment with the correct definitions.

9.2 Identify parts of a parallel bar.

9.3 List three advantages of a parallel bar.

9.4 Describe the operation of a parallel bar.

9.5 Describe the use of an adjustable triangle.

9.6 Identify the parts of an elbow drafting machine.

9.7 List four advantages of an elbow drafting machine.

9.8 Describe the operation of an elbow drafting machine.

9.9 Identify the parts of a V-track drafting machine.

9.10 List four advantages of a V-track drafting machine.

9.11 Describe the operation of a V-track drafting machine.

9.12 Select rules to remember in the maintenance and care of drafting machines.

9.13 Operate a parallel bar.

9.14 Operate an adjustable triangle.

9.15 Measure angles with the protractor and vernier scale on a drafting machine.

MODULE: DRAFTING FUNDAMENTALS

UNIT IX: MAJOR DRAFTING EQUIPMENT

CONTENTS OF THIS UNIT

A. Objective sheets

B. References

C. Notes to the Instructor

D. Lesson plans

1. Lesson 1: MAJOR EQUIPMENT

   a. Information outline

   b. Transparency masters

      TM 9.1: Parts of a Parallel Bar
      TM 9.2: Adjustable Triangle
      TM 9.3: Parts of an Elbow Drafting Machine
      TM 9.4: Parts of a Standard Protractor Head
      TM 9.5: Parts of a V-Track Drafting Machine

   c. Assignment sheets

      AS 9.1: Operate a Parallel Bar
      AS 9.2 Operate an Adjustable Triangle
      AS 9.3 Measure Angles with the Protractor and Vernier Scale on a Drafting Machine

   d. Answers to assignment sheets

   e. Job Sheets

      JS 9.1: Make Adjustments to a V-Track Drafting Machine to Install and Align Scales
      JS 9.2: Make Adjustments to an Elbow Drafting Machine to Install and Align Scales

E. Unit test

F. Answers to unit test

REFERENCES

1. Brown, Walter C. Drafting for Industry. South Holland, Ill. 60473: Goodheart-Wilcox Co., Inc., 1974.

2. Davis, Ronald, Bill Hill, and Bruce Yancey. Basic Drafting Book One and Book Two. Stillwater, Okla. 74074: Mid-America Vocational Curriculum Consortium, Inc., 1981.

3. Dygdon, John Thomas and Henry Cecil Spencer. Basic Technical Drawing. New York 10022: Macmillan Publishing Co., Inc., 1968.

MODULE: DRAFTING FUNDAMENTALS

UNIT IX: MAJOR DRAFTING EQUIPMENT

LESSON 1: MAJOR EQUIPMENT

I. Terms and definitions

A. Drawing media--any type of drawing material upon which an object is graphically represented

B. Ellipse--a foreshortened circle with a major and minor diameter

C. Horizontal--parallel to the plane of the horizon

D. Parallel--two lines or surfaces side by side, equal distances apart at all points

E. Perpendicular--at a 90° angle to a given plane or line

F. Vernier--a measuring device consisting of a main fixed scale and a smaller graduated scale that slides to obtain fine measurements

G. Vertical--a line straight up and down, perpendicular to the horizontal plane

H. Working edge--an edge used as a point of reference, such as the edge of a drawing board or T-square

I. Working surface--any surface such as a drafting board or desk used to secure drawing media

II. Parts of a parallel bar (TM 9.1)

A. Cable

B. Bar

C. Cable clamp

D. Cable pulleys

E. Tension bracket

III. Advantages of a parallel bar

A. Easy to make long horizontal lines

B. More accurate than a T-square

C. Very little maintenance

D. Simple to operate

IV. Operation of a parallel bar--a parallel bar is a long flat bar similar to a T-square that has a hollow area in its middle through which cables pass. These cables work through a series of pulleys, and the ends are attached to a tension bracket. The cables allow the bar to move in a parallel motion up and down the working surface (TM 9.1)

V. Use of an adjustable triangle--an adjustable triangle is used in combination with a T-square or parallel bar to lay out lines that are not at the standard 15° increment (TM 9.2)

VI. Parts of an elbow drafting machine (TMs 9.3 and 9.4)

- A. Clamp
- B. Upper arm
- C. Lower arm
- D. Elbow brake
- E. Standard protractor head (TM 9.4)
- F. Vertical scale
- G. Horizontal scale
- H. Protractor
- I. Handle
- J. Base line wing nut
- K. Index thumbpiece
- L. Protractor brake wing nut
- M. Chuck plate
- N. Vernier plate
- O. Scale chuck
- P. Adjusting screw

VII. Advantages of an elbow drafting machine

- A. Increases drafting output
- B. Requires fewer tools to operate
- C. Less expensive than parallel track machine
- D. Can be aligned to any base line
- E. More accurate than separate protractor instrument
- F. Can be operated from any side of the drawing desk

VIII. Operation of an elbow drafting machine--an elbow drafting machine has a protractor head which can be adjusted to any angle measurement accurate to the nearest 5 minutes of a degree--the protractor head moves in any direction on the working surface--the head is mounted at the end of two arms hinged in the middle with an elbow swivel joint--this allows the drafter to make parallel lines at any angle

IX. Parts of a V-track drafting machine (TMs 9.4 and 9.5)

A. Mounting clamp

B. Horizontal track

C. Vertical track

D. Standard protractor head

E. Vertical scale

F. Horizontal scale

G. Vertical motion brake

H. Horizontal motion brake

I. Protractor head pivot point

X. Advantages of a V-track drafting machine

A. Simple to operate

B. Versatile

C. Accuracy is better maintained

D. All areas of drawing board accessible

E. Few working parts

XI. Operation of a V-track drafting machine: The V-track machine has a protractor head which can be adjusted to any angle measurement accurate to the nearest 5 minutes of a degree; this protractor head moves on a vertical track which in turn moves on a horizontal track--this allows the drafter to make parallel lines in any direction

XII. Rules to remember in maintenance and care of drafting machines

A. Keep support clamps secured snugly to desk

B. Keep scales aligned and tight

(**CAUTION**: Do not over tighten)

C. Keep scales clean

D. Keep scales flat on working surface; do not lift machine by scales

E. Keep band tension adjusted properly

F. Protractor head should adjust easily

(**CAUTION:** Do not force--check protractor brake wing nut)

G. Tighten baseline and protractor wing nuts snugly but not too tight

(**CAUTION:** Do not force)

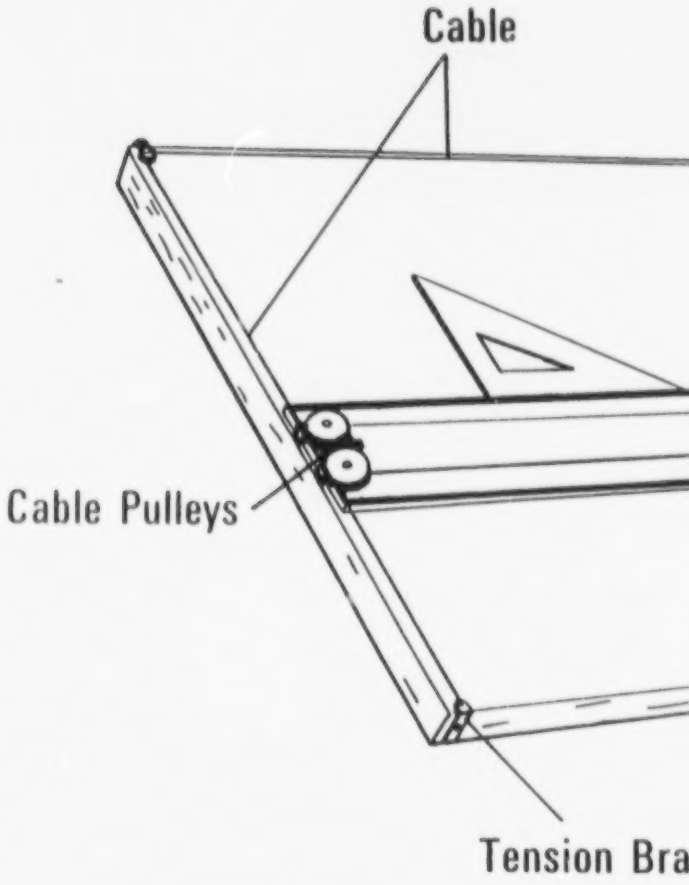
H. Lift machine by handle to move from position to position

I. Make sure scales are never used to cut or tear paper

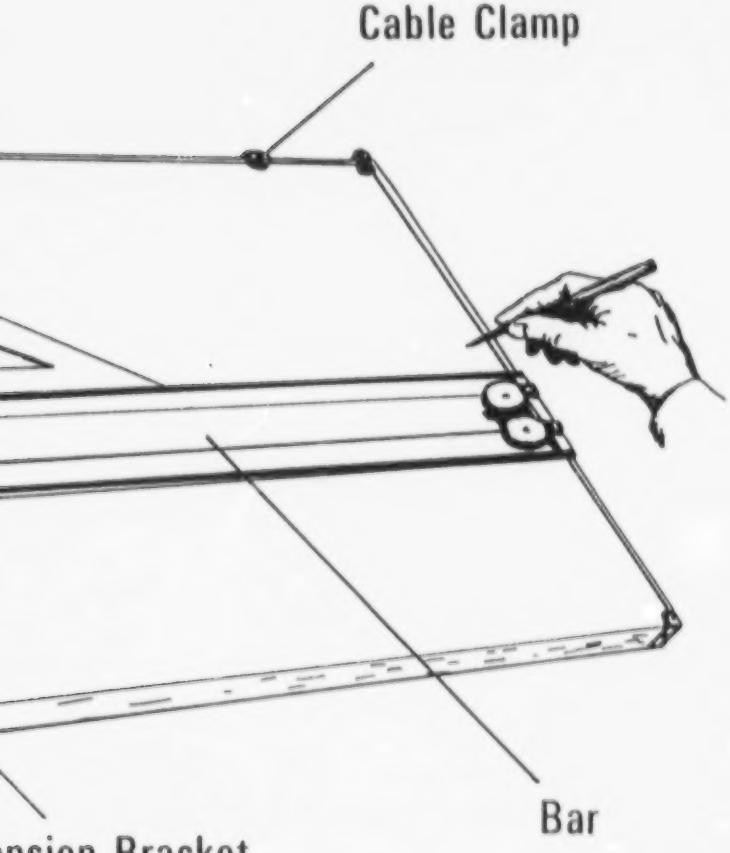
J. Never use scales as straight edges for cutting with a knife

K. Never store drafting machine with scales protruding over the edge of the drafting table

PARTS OF A PA

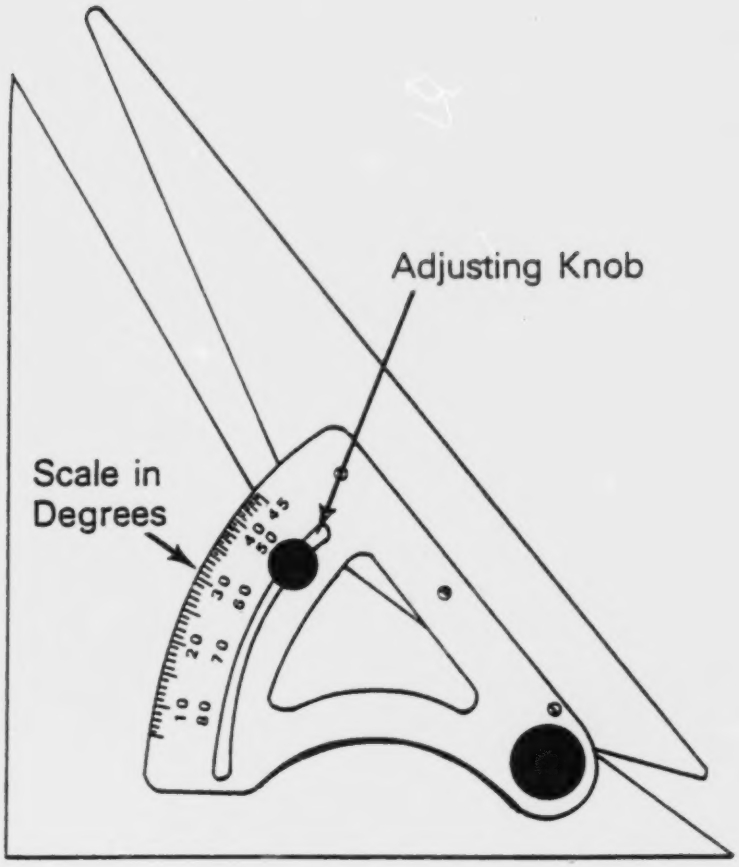


OF A PARALLEL BAR



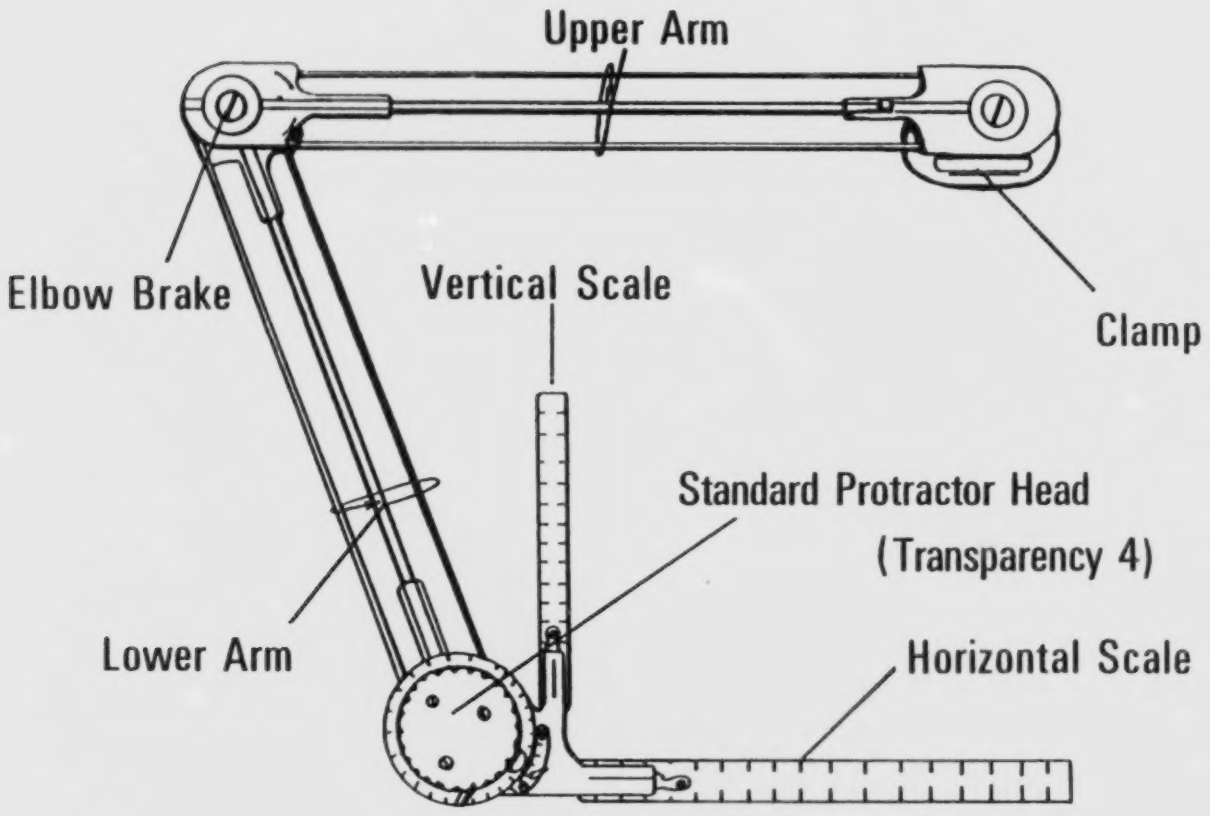
TM 9.1

ADJUSTABLE TRIANGLE

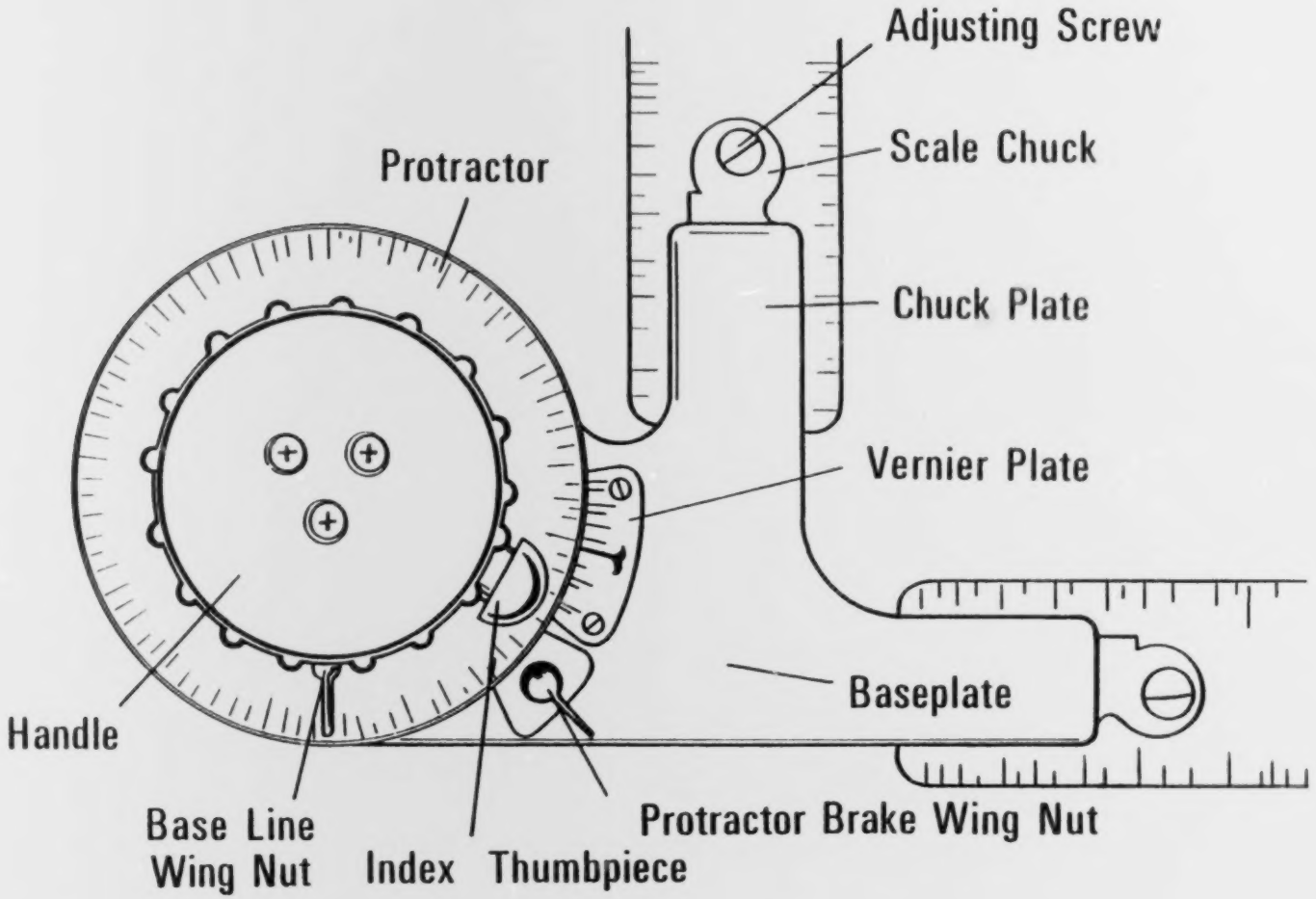


NOTE: In Closed Position
Triangle forms Standard 45° Triangle

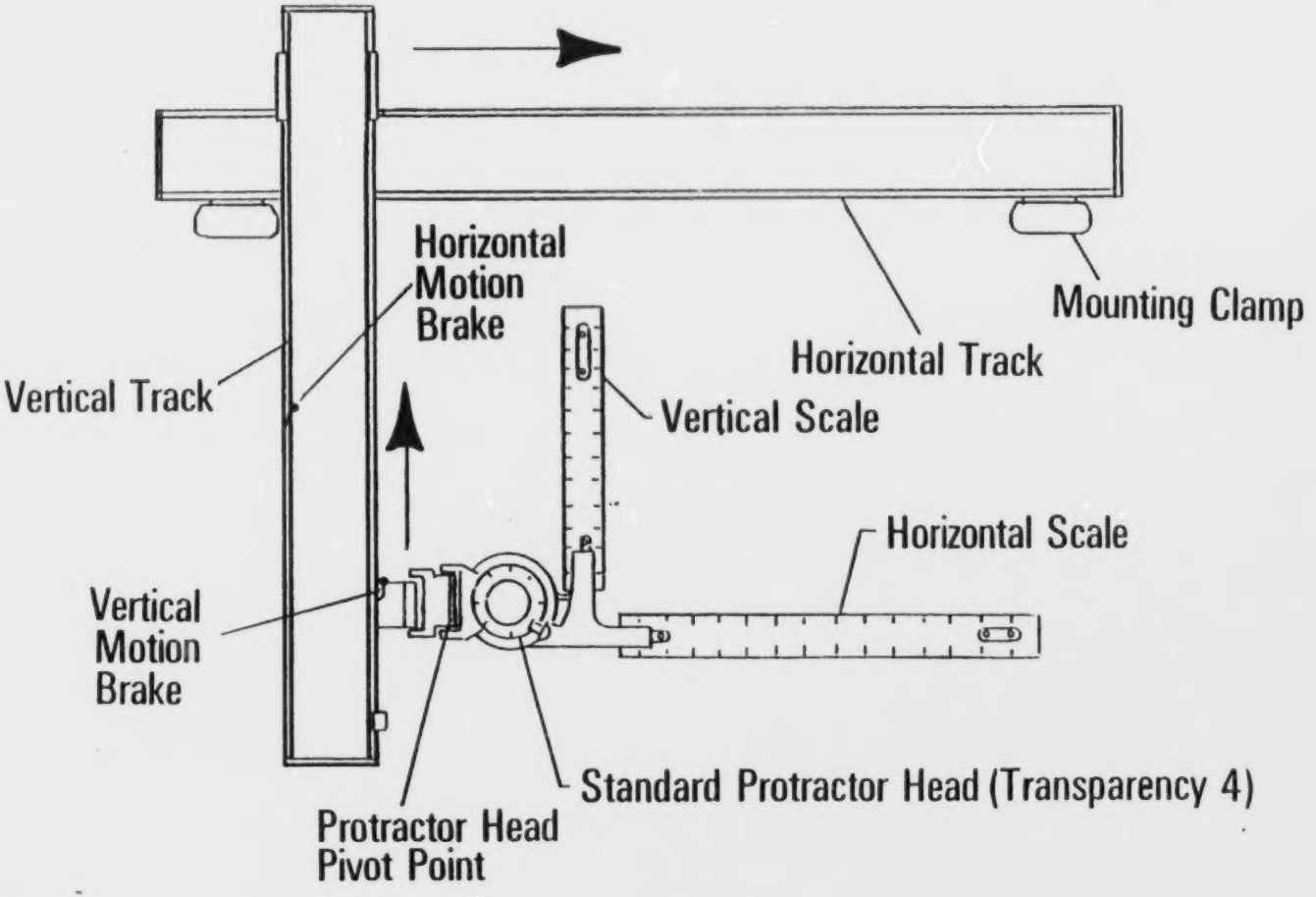
PARTS OF AN ELBOW DRAFTING MACHINE



PARTS OF A STANDARD PROTRACTOR HEAD



PARTS OF A V-TRACK DRAFTING MACHINE



OPERATE A PARALLEL BAR

Procedure:

A. Loosen cable clamp as required (Figure 1).

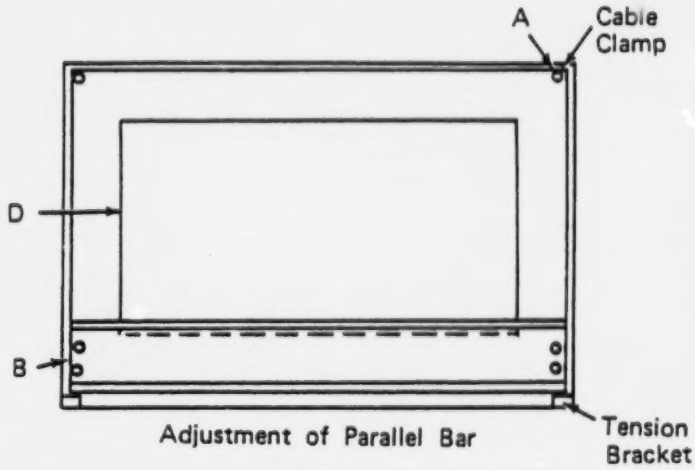
B. Move parallel bar to bottom limit of drawing surface.

C. Both ends of parallel bar should be in contact with tension brackets.

D. Place drawing media on working surface so that top edge of parallel bar does not catch bottom edge of drawing media.

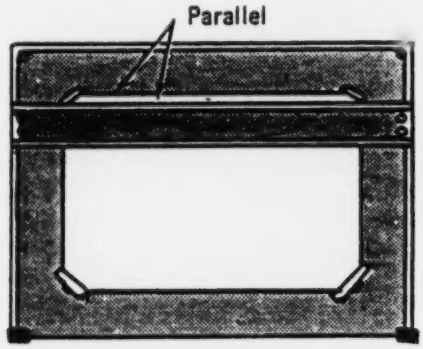
E. Move top edge of parallel bar up and align with top edge of drawing media (Figure 2).

F. Hold drawing media in position and tape corners to working surface.



Adjustment of Parallel Bar

Figure 1



Positioning the paper on the board

Figure 2

G. Tighten cable clamp adjustment as required.

H. Move parallel bar up and down on the working surface by holding the middle of the parallel bar and lifting slightly.

I. Place triangles on top edge of parallel bar (Figure 3).

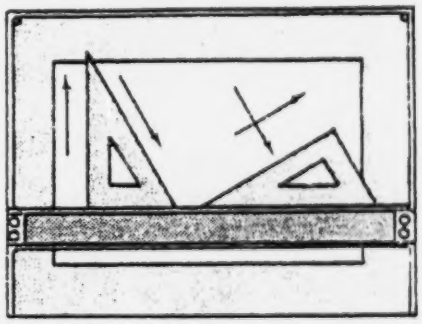
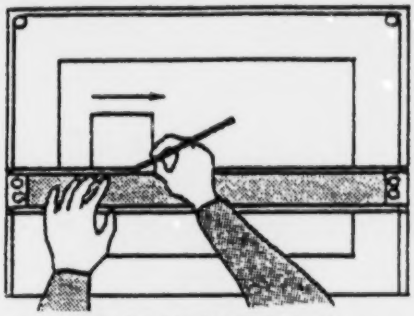


Figure 3

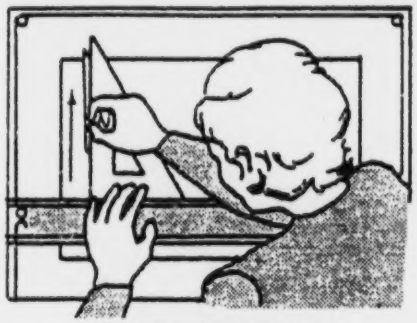
J. Check working edge of bar frequently to make sure it is maintaining proper alignment with horizontal lines of drawing.

K. Use pencil to draw horizontal lines (Figure 4).

L. Use pencil and triangle to draw vertical lines (Figure 5).



Drawing Horizontal Lines
Figure 4



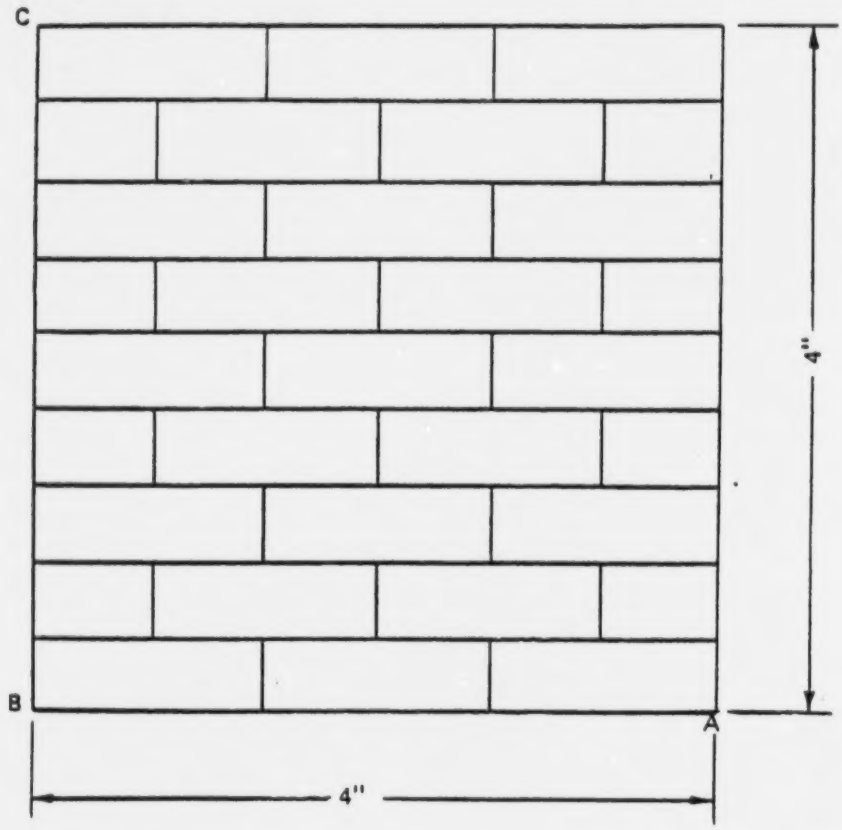
Drawing Vertical Lines
Figure 5

M. Practice slanting the pencil in the direction of travel and rotating pencil in right hand when drawing a line.

Problems:

A. Operate a parallel bar and triangles to construct the following figure.

Directions: Use "B" (11 X 17) size drawing vellum with standard border and title block. Divide the working space into two equal areas. Center in the left hand area, construct the following figure using proper techniques.

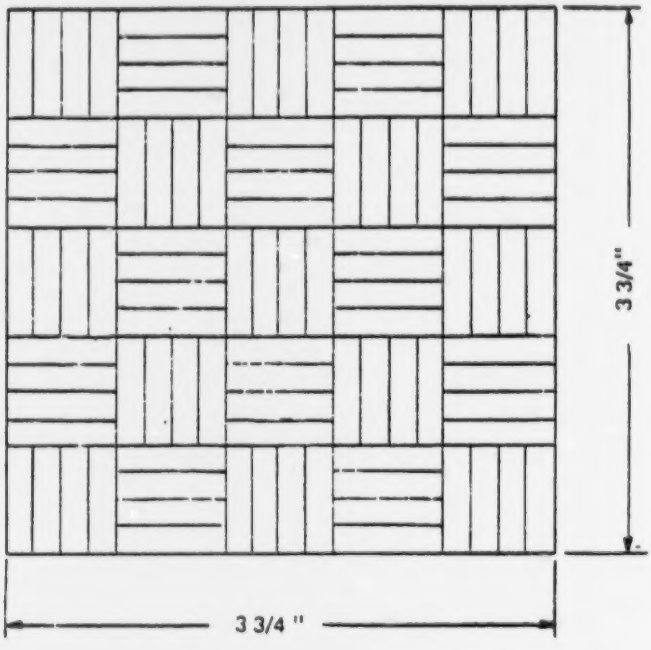


Line B-C is Divided into 9 equal parts
Line A-B is divided into 6 equal parts

NOTE: Work at keeping all object lines the same width and darkness.

B. Operate a parallel bar and a triangle to construct the following figure.

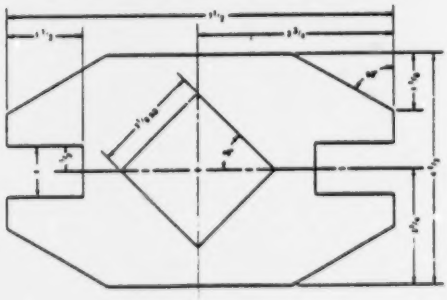
Directions: Use the right hand area of problem "A" drawing vellum. Construct the following grid pattern using proper techniques.



NOTE: Accuracy is a "must" for a drafter; start now working on accuracy of spacing and keeping all corners clean and sharp.

C. Operate a parallel bar and triangles to construct the following figure.

Directions: Use "A" size drawing vellum with standard border and title block. Construct the following figure using proper techniques. Omit all dimensions.



NOTE: Drawing should be centered in working space by finding center of working space by crossed diagonals.

OPERATE AN ADJUSTABLE TRIANGLE

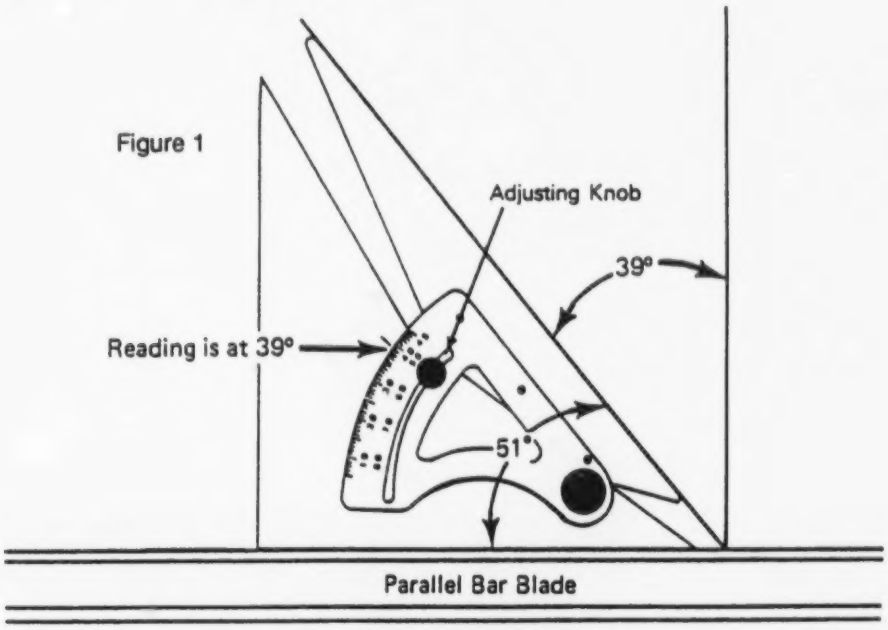
Procedure:

A. Set required angle on triangle by loosening adjusting knob and setting the scale (Figure 1).

B. Read numbers on lower half of scale, if required angle is greater than 45, the angle will be the actual angle made by the triangle.

C. Read numbers on upper half of scale, if required angle is less than 45, the angle will be complementary to the triangle.

Figure 1



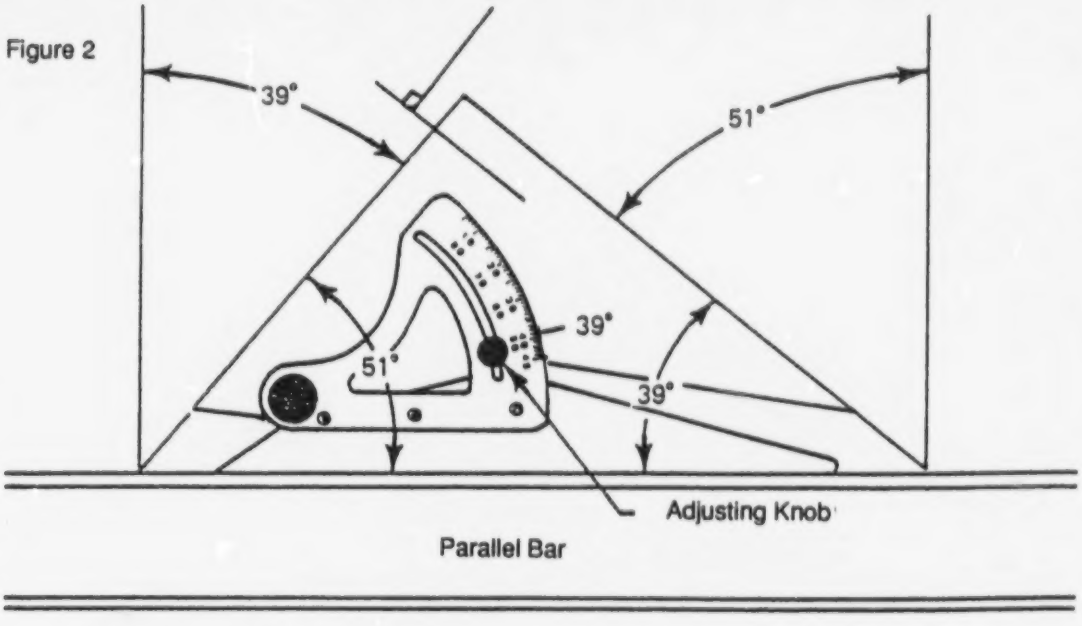
Note– In Closed Position
Triangle forms Standard 45° Triangle

NOTE: In closed position triangle forms standard 45° triangle.

D. Adjustable triangle can be adjusted so that the long side can serve as the base line. This changes the direction the individual lines will run (Figure 2).

NOTE: Using long side as base allows you to construct perpendicular lines merely by sliding the triangle.

Figure 2

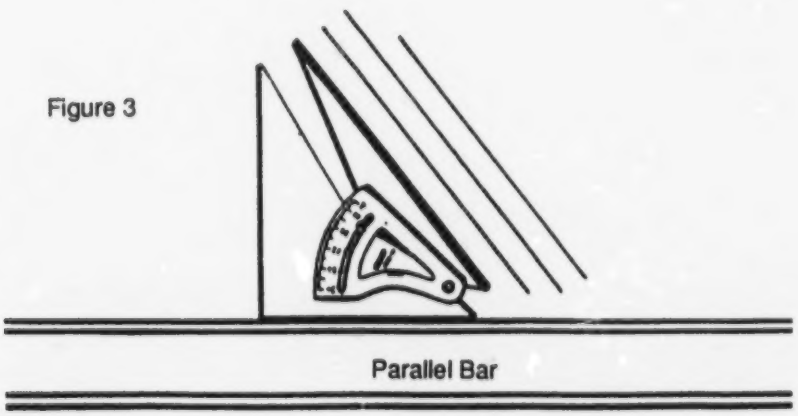


E. Practice setting various angles and rotating triangle to get various line angles.

F. Construct parallel lines by drawing along one edge of the triangle (Figure 3).

G. Slide the triangle along working edge to new position and construct the new line (Figure 3).

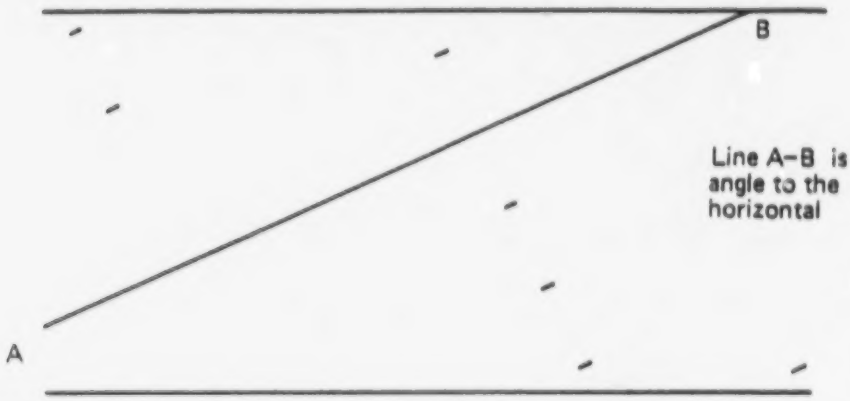
Figure 3



Problem:

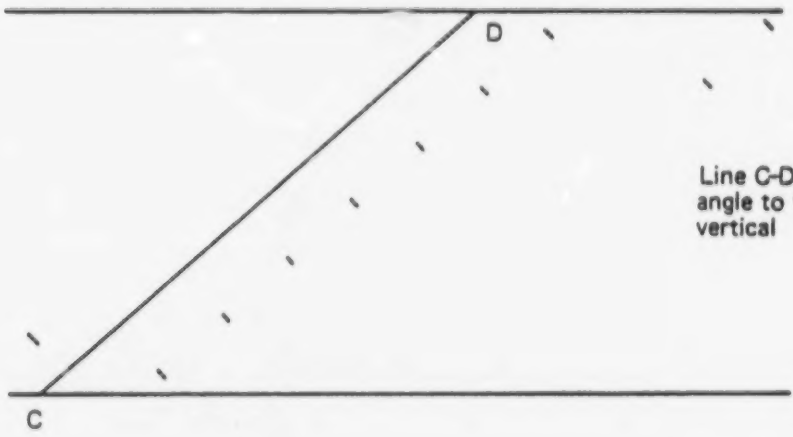
Directions: Complete the figures below using a parallel bar and adjustable triangle.

Draw lines parallel to given line through given points.



Line A–B is a _____ angle to the horizontal

Draw lines perpendicular to given line through given points.



Line C-D is a _____ angle to the vertical

MEASURE ANGLES WITH THE PROTRACTOR AND VERNIER SCALE ON A DRAFTING MACHINE

Procedure

A. Operation of the standard protractor head

NOTE: The standard protractor head is divided into one degree units with a side mounted vernier scale divided into five minute readings. The protractor has 4 quarters of 90° each.

1. Push indexing thumbpiece in and rotate head.

   NOTE: Protractor will automatically lock ever 15 degrees.

2. Push indexing thumbpiece in and down.

   NOTE: This procedure will lock the indexer in the open position and free the protractor head to completely rotate.

   (CAUTION: NEVER FORCE the head if it does not rotate freely; check protractor brake wing nut.)

B. Measuring angles

NOTE: The standard protractor head is designed to read an angle to the nearest 5 minutes of a degree. Remember, there are 360° in a circle and 60 minutes in one degree.

1. Locate the "0" on the protractor and the "0" on the vernier scale .

2. Push thumb index in.

3. Slide the "0" on the vernier up or down the protractor until it lines up with the degree mark needed on the protractor (Figure 1-a).

   Example:

   1. Assume the vernier is set at a positive (upward) angle.

   2. Note the reading is between 7 and 8 degrees.

3. Find the 5 minute mark on the upper half of the vernier which is most closely in alignment with a degree mark.

NOTE: The correct reading is 7°40'. The procedure is the same when reading negative (downward); in this case the reading is 4°25'. Refer to Figure 1-b.

Figure 1-a

Figure 1-b

C. Setting angles

1. Release the protractor brake wing nut.
2. Push the index thumbpiece in and down to release the index.
3. Rotate the protractor arm until the zero of the vernier is at the desired degree.
4. Rotate (slowly) the protractor arm counter-clockwise until the desired minute mark on the upper half of the vernier is precisely aligned with the nearest degree mark on the protractor.
5. Lock the protractor brake wing nut.

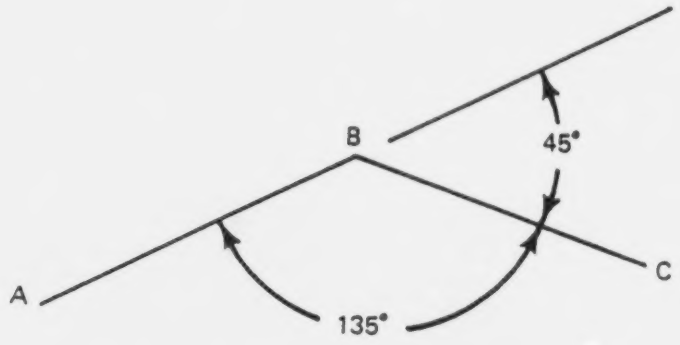
NOTE: The procedure for setting negative angles is essentially the same except the protractor head is rotated clockwise.

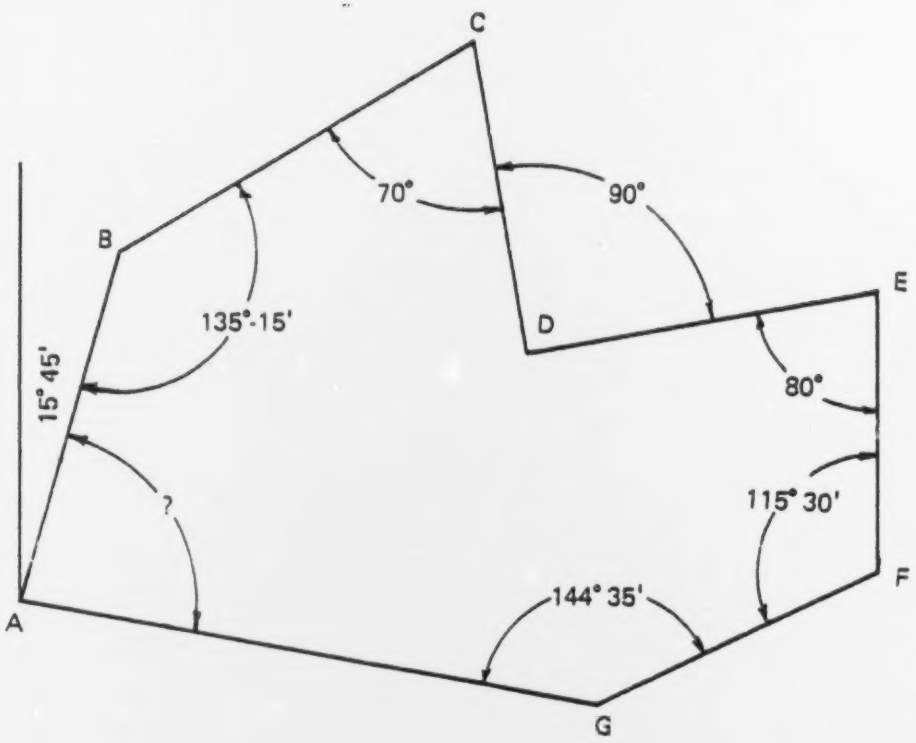
Problem:

Directions: Use "A" size drawing vellum with standard border and title block. Construct the following figure using STD protractor head with vernier scale to lay out all angles. Start at point A. Label all corners, show dimensions in table form. Measure and label closing angle (B, A, G,) and find the length of G, A to the nearest 32nd. All angles should be calculated using the deflection method illustrated in Figure 2 of the example before starting the drawing.

Example: Deflection method

1. Extend line AB beyond object giving 180° line.
2. Subtract known 135° from 180° line.
3. Set base line scale on 180° line.
4. Set protractor head at 45°.
5. Construct line B-C.





A,B = 2"
B,C = 2 11/32"
C,D = 1 3/4"
D,E = 2"
E,F = 1 17/32"
F,G = 1 3/4"

G,A = _____ B,A,G = _____

NOTE: Required angles to draw figure have to be calculated. Use deflection method.

ANSWERS TO ASSIGNMENT SHEETS 1.1 - 1.3

AS 1.1

Evaluated to The satisfaction of the instructor.

AS 1.2

Line A-B = 25° angle

Line C-D = 48° angle

AS 1.3

G,A = 3 5/16

BAG = 84° 30'

MAKE ADJUSTMENTS TO A V-TRACK DRAFTING MACHINE TO INSTALL AND ALIGN SCALES

I. Tools and equipment

- A. V-track drafting machine
- B. Drawing surface
- C. Horizontal machine scale
- D. Vertical machine scale
- E. Scale wrench
- F. Hex wrench
- G. Pencil
- H. Drawing media

II. Procedure

A. Insert scales

1. Tighten flathead chuck plate screws on both vertical and horizontal scales.

   (**CAUTION:** Do not overtighten plastic scales!!)

2. Place scales flat on working surface in line with scale chucks on protractor and firmly press, do not drive, the chuck plate on the scale into the chuck.

   (**CAUTION:** Do not blend scales as you apply pressure.)

B. Remove scales--Release scales by means of scale wrench.

NOTE: With the pin side of the wrench downward, slip the wrench over the pinhead screw and turn clockwise, pressing the curved part of wrench against end of scale chuck. (Figure 1)

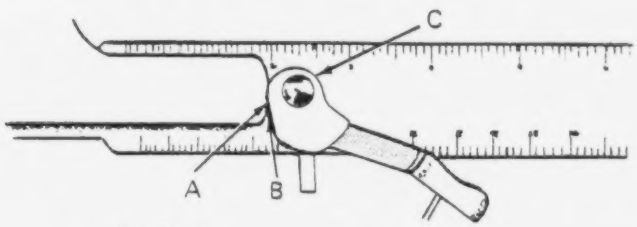


Figure 1

C. Align scales

1. Install scales

a. Tighten flathead screws on each chuck plate.

b. Insert scales in base plate, and press them firmly into place.

c. Loosen the panhead screw on horizontal scale, and set scale near the center of its angular range of adjustment.

d. Tighten panhead screw on horizontal scale.

2. Align horizontal scale

a. Draw a reference line parallel to the horizontal track by:

1) Locking the vertical brake and releasing the horizontal brake.

2) Placing pencil point at zero on the horizontal scale and moving pencil and protractor head together laterally along the board.

NOTE: Merely drawing the pencil along the scale will not assure a line parallel to the horizontal track.

b. Release the base line wing nut and bring the horizontal scale parallel to the reference line (Figure 2).

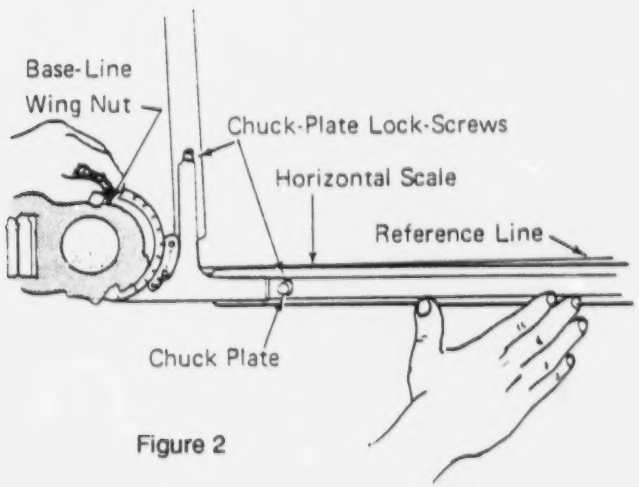


Figure 2

c. Tighten the base line wing nut.

3. Align vertical scale

a. Index the head 90 degrees clockwise (Figure 3).

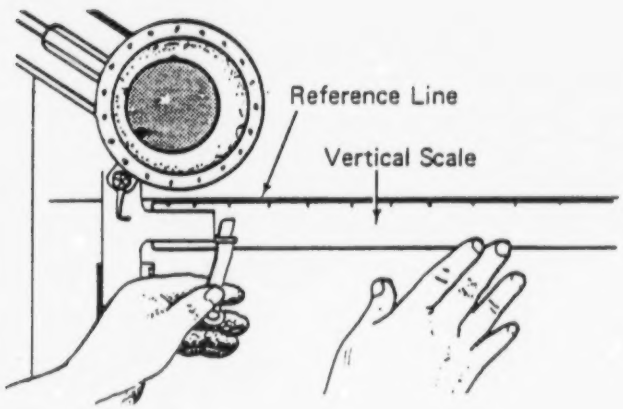


Figure 3

b. Loosen panhead screw on vertical scale.

c. Adjust vertical scale to the reference line.

d. Tighten panhead screw on vertical scale.

e. Index the head 90 degrees counter-clockwise so that horizontal scale is parallel with reference line.

NOTE: This setting is extremely important and should be checked periodically.

MAKE ADJUSTMENTS TO AN ELBOW DRAFTING MACHINE TO INSTALL AND ALIGN SCALES

I. Tools and equipment

A. Elbow drafting machine

B. Drawing surface

C. Horizontal machine scale

D. Vertical machine scale

E. Scale wrench

F. Pencil

G. Drawing media

II. Procedures

A. Insert scales

1. Tighten flathead chuck plate screws on both vertical and horizontal scales.

   (**CAUTION:** Do not overtighten plastic scales!!)

2. Place scales flat on board in line with scale chucks on protractor head. Firmly press, do not drive, the chuck plates on the scales into the chucks.

   (**CAUTION:** Do not bend scales as you apply pressure.)

B. Remove scales by means of a scale wrench

NOTE: With the pin side of the wrench downward, slide the wrench over the panhead screw on scale and turn clockwise, pressing the curved part of wrench strongly against end of scale chuck. Figure 1.

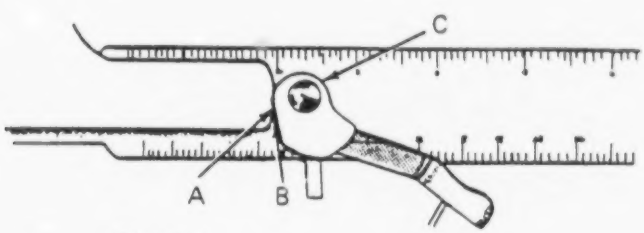


Figure 1

C. Align scales

1. Install scales

   a. Tighten flathead screws on each chuck plate.

   b. Insert scales in base plate and press them firmly into place.

      NOTE: See Procedure step A-2.

2. Align horizontal scale

   a. Loosen the panhead screw on horizontal scale, and set scale near the center of its angular range of adjustment.

   b. Tighten panhead screw on horizontal scale.

   c. Loosen base line wing nut and set horizontal scale parallel to bottom of drawing surface.

   d. Tighten base line wing nut.

   e. Draw a light reference line the length of horizontal scale.

3. Align vertical scale

   a. Index the head 90° clockwise.

   b. Loosen the panhead screw on vertical scale and bring the vertical scale parallel to the reference line (Figure 2).

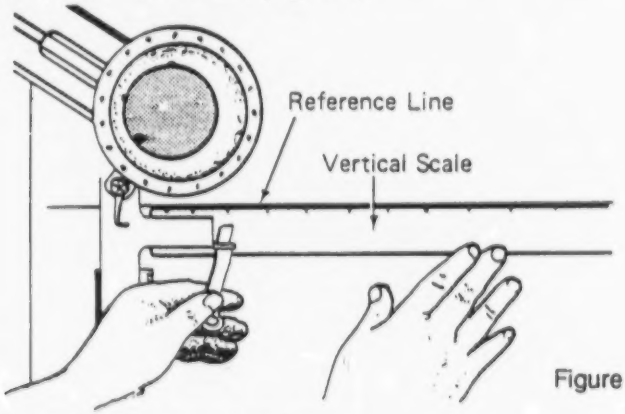


Figure 2

   c. Tighten panhead screw on vertical scale.

   d. Index head back 90° counter-clockwise and check horizontal scale once more.

      NOTE: Scales can be checked by placing large 90° triangle on horizontal scale and sliding up against vertical scale.

D. Test for loose bands

1. Draw a horizontal reference line on drawing media.
2. Lift protractor head slightly and move machine around working surface several times.
3. Return horizontal scale to reference line.
4. Check for movement from parallel.
5. Refer to owner's manual for correct procedures to adjust bands for any given machine.

MODULE: DRAFTING FUNDAMENTALS

UNIT IX: MAJOR DRAFTING EQUIPMENT

UNIT TEST

Match the terms on the right to their correct definitions on the left.

___	1.	At a 90° angle to a given plane or line	a.	Horizontal
___	2.	Any surface such as a drafting board or desk used to secure drawing media	b.	Vertical
___	3.	Two lines or surfaces side by side, equal distances apart at all points	c.	Drawing media
___	4.	An edge used as a point of reference, such as the edge of a drawing board or T-square	d.	Working surface
___	5.	Parallel to the plane of the horizon	e.	Perpendicular
___	6.	Any type of drawing material upon which an object is graphically represented	ab.	Parallel
___	7.	A line straight up and down, perpendicular to the horizontal plane	ac.	Working edge
___	8.	A measuring device consisting of a smaller main fixed scale and a smaller graduated scale that slides to obtain fine measurements	ad.	Ellipse
___	9.	A foreshortened circle with a major and minor diameter	ae.	Vernier

Select rules to remember concerning maintenance and care of drafting machines by marking a "T" for true statements and an "F" for false statements.

___ 10. Keep scales aligned and tight

___ 11. Scales can be used as straight edge for exacto knife

___ 12. Scales do not need to be kept clean

___ 13. Tighten baseline and protractor wing nuts snugly but not too tight

___ 14. Store drafting machine with scales over the edge of the drafting table out of the way

___ 15. Lift and move drafting machine by the scales

___ 16. Protractor heads are hard to adjust, force if necessary

___ 17. Keep band tension adjusted properly

___ 18. Keep support clamps loose when not in use

19. List two advantages of a V-track drafting machine.

a. _____

b. _____

20. List two advantages of an elbow drafting machine.

a. _____

b. _____

21. List two advantages of a parallel bar.

a. _____

b. _____

Identify the parts of a parallel bar by placing the correct letter to the left of its corresponding name.

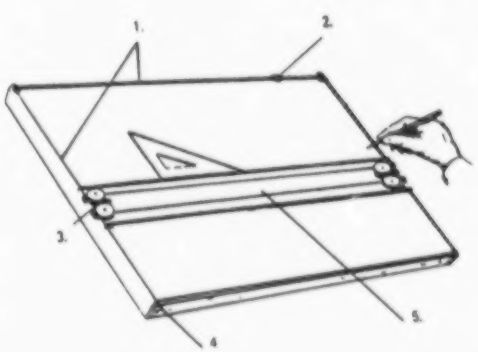
___ 22. Bar

___ 23. Cable pulleys

___ 24. Cable clamp

___ 25. Tension bracket

___ 26. Cable



Identify the parts of an elbow drafting machine by placing the correct letter or combination of letters to the left of the corresponding name.

___ 27. Elbow brake

___ 28. Upper arm

___ 29. Clamp

___ 30. Horizontal scale

___ 31. Vertical scale

___ 32. Protractor

___ 33. Adjusting screw

___ 34. Scale chuck

___ 35. Vernier plate

___ 36. Chuck plate

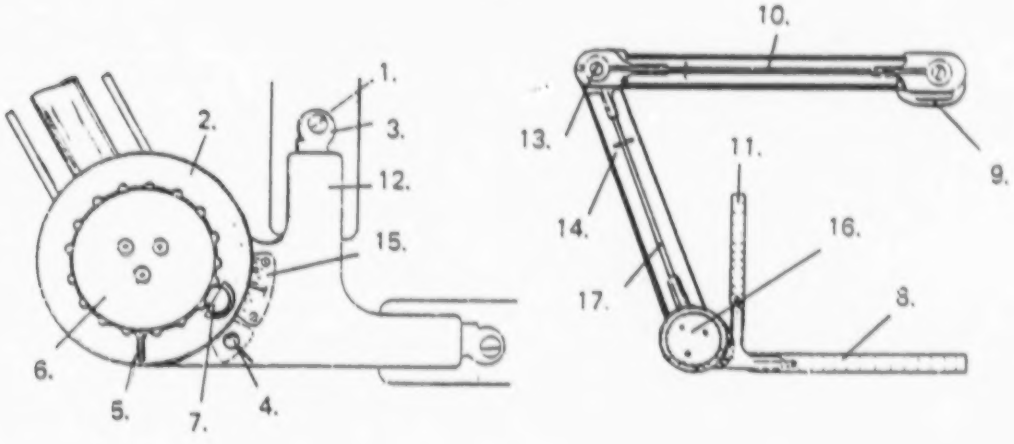
___ 37. Protractor brake wing nut

___ 38. Index thumbpiece

___ 39. Base line wing nut

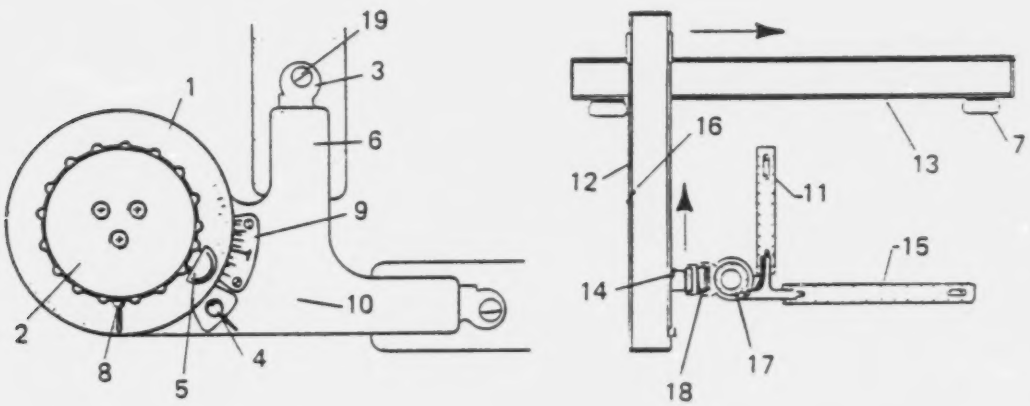
___ 40. Handle

___ 41. Standard protractor head



Identify the parts of a V-track drafting machine by placing the correct letter or combination of letters to the left of the corresponding name.

___ 42.	Horizontal motion brake	___ 50.	Chuck plate
___ 43.	Handle	___ 51.	Protractor brake wing nut
___ 44.	Scale chuck	___ 52.	Vernier plate
___ 45.	Mounting clamp	___ 53.	Protractor
___ 46.	Horizontal track	___ 54.	Index thumbpiece
___ 47.	Standard protractor head	___ 55.	Baseplate
___ 48.	Vertical scale	___ 56.	Adjusting screw
___ 49.	Vertical motion brake		



57. Describe the use of an adjustable triangle.

58. Describe the operation of an elbow drafting machine.

59. Describe the operation of a parallel bar.

60. Describe how a V-track drafting machine operates.

ANSWERS TO UNIT IX TEST

1. e (B1)
2. d (B1)
3. ab (B1)
4. ac (B1)
5. a (B1)
6. c (B1)
7. b (B1)
8. ae (B1)
9. ad (B1)
10. T (B6)
11. F (B6)
12. F (B6)
13. T (B6)
14. F (B6)
15. F (B6)
16. F (B6)
17. T (B6)
18. F (B6)

19. Any two of the following: (B6)
    a. Simple to operate
    b. Versatile
    c. Accuracy is better maintained
    d. All areas of drawing board accessible
    e. Few working parts
20. Any two of the following: (B6)
    a. Increases drafting output
    b. Requires fewer tools to operate
    c. Less expensive than parallel track machine
    d. Can be aligned to any base line
    e. More accurate than separate protractor instrument
    f. Can be operated from any side of the drawing desk
21. Any two of the following: (B6)
    a. Easy to make long horizontal lines
    b. More accurate than a T-square
    c. Very little maintenance

d. Simple to operate

22. 5 (B6)
23. 3 (B6)
24. 4 (B6)
25. 2 (B6)
26. 1 (B6)
27. 13 (B6)
28. 10 (B6)
29. 9 (B6)
30. 8 (B6)
31. 11 (B6)
32. 2 (B6)
33. 1 (B6)
34. 3 (B6)
35. 15 (B6)
36. 12 (B6)
37. 4 (B6)
38. 7 (B6)
39. 5 (B6)
40. 6 (B6)
41. 16 (B6)
42. 16 (B6)
43. 2 (B6)
44. 3 (B6)
45. 7 (B6)
46. 13 (B6)
47. 17 (B6)
48. 11 (B6)
49. 14 (B6)
50. 6 (B6)
51. 4 (B6)
52. 9 (B6)
53. 1 (B6)
54. 5 (B6)
55. 10 (B6)
56. 19 (B6)

57. An adjustable triangle is used in combination with a T-square or parallel bar to lay out lines that are not at the standard 15° increment. (B6)

58. An elbow drafting machine has a protractor head which can be adjusted to any angle measurement accurate to the nearest 5 minutes of a degree. The protractor head moves in any direction on the working surface. The head is mounted at the end of two arm hinges in the middle with an elbow swivel joint. This allows the drafter to make parallel lines at any angle. (B6)

59. A parallel bar is a long flat bar similar to a T-square that has a hollow area in its middle through which cables pass. These cables work through a series of pulleys, and the ends are attached to a tension bracket. The cables allow the bar to move in a parallel motion up and down the working surface. (B6)

60. The V-track machine has a protractor head which can be adjusted to any angle measurement accurate to the nearest 5 minutes of a degree; this protractor head moves on a vertical track which in turn moves on a horizontal track. This allows the drafter to make parallel lines in any direction. (B6)

MODULE: DRAFTING FUNDAMENTALS

UNIT X: INKING TOOLS AND TECHNIQUES

UNIT OBJECTIVE

After completion of this unit, the student should be able to select types of inks, their quality requirements, properties, and performance and types of pen points. The student should also be able to draw and erase ink lines on various media and clean, fill, and refill various types of pens. This knowledge will be evidenced by correctly performing the procedures outlined in the assignment and job sheets and by scoring ___ percent on the unit test.

SPECIFIC OBJECTIVES

10.1 Match terms related to inking tools and techniques with their correct definitions.

10.2 List three types of pen points.

10.3 Select true statements concerning the ways to properly use and care for technical pens.

10.4 Select true statements concerning characteristics of polyester film and procedures for using ink on polyester film.

10.5 Discuss useful tips for working with ink.

10.6 Complete a chart of the alphabet of ink lines.

10.7 Demonstrate the ability to:

a. Draw and erase ink lines on vellum or tracing cloth.

b. Draw and erase ink lines on polyester film.

c. Complete steps in inking a drawing or a tracing.

d. Fill clean technical and pocket model pens.

e. Refill a technical pen.

f. Clean technical and pocket model pens using the standard cleaning method.

g. Clean a technical pen with an ultrasonic cleaner.

MODULE: DRAFTING FUNDAMENTALS

UNIT X: INKING TOOLS AND TECHNIQUES

CONTENTS OF THIS UNIT

A. Objective sheets

B. References

C. Notes to the instructor

D. Lesson plans

1. Lesson 1: INKING

   a. Information outline

   b. Transparency masters

      TM 10.1: Technical Pen Parts
      TM 10.2: Pen Point
      TM 10.3: Manual Lettering Device

   c. Assignment sheets

      AS 10.1: Draw and Erase Ink Lines on Vellum or Tracing Cloth
      AS 10.2: Draw and Erase Ink Lines on Polyester Film
      AS 10.3: Complete Steps in Inking a Drawing or a Tracing
      AS 10.4: Draw Lines on a Drawing Medium Using Ink

   d. Job sheets

      JS 10.1:Fill Clean Technical and Pocket Model Pens
      JS 10.2:Refill a Technical Pen
      JS 10.3:Clean Technical and Pocket Model Pens Using the Standard Cleaning Method
      JS 10.4:Clean a Technical Pen with an Ultrasonic Cleaner

E. Unit test

F. Answers to unit test

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2. Davis, Ronald, Bill Hill, and Bruce Yancey. Basic Drafting Book One and Book Two. Stillwater, Okla. 74074: Mid-America Vocational Curriculum Consortium, Inc., 1981.

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9. American National Standards Institute. Line Conventions and Lettering. New York: The American Society of Mechanical Engineers, 1979.

10. Koh-I-Noor. Rapidraw Learning Program Workbook. Bloomsbury, N.J.: Koh-I-Noor Rapidograph, Inc.

11. The Koh-I-Noor Rapidraw System. Bloomsbury, N.J.: Koh-I-Noor Rapidograph, Inc.

NOTES TO THE INSTRUCTOR

A. Suggested approaches to teaching this unit

1. Demonstrate the use of and the advantages and disadvantages of the electric eraser and the ultrasonic pen cleaner.

MODULE: DRAFTING FUNDAMENTALS

UNIT X: INKING TOOLS AND TECHNIQUES

LESSON 1: INKING

I. Terms and definitions (TMs 10.1, 10.2, 10.3)

A. Adhesion--firm or steady attachment

B. Compass adapter--a device for technical pens to hold the pen in the proper position in a compass

C. Compatible--capable of forming an homogenous (single) mixture that does not separate or alter by chemical interaction with each individual substance or material

D. Feathering--occurs when an ink line spreads in an uneven fashion; usually due to drawing on the wire side of the vellum

E. Ink--liquid composed mainly of carbon in colloidal suspension (latex or solutions of special shellac) and gum

NOTE: Fine particles of carbon give ink its deep dark, black appearance, and the gum makes it quick to dry and water proof.

F. Ink riser--thin plastic template placed under a template or triangle so that ink will not run under template or triangle

G. Ink triangle--a straight-edged three sided device whose total angles equal 180° made of thin, flat plastic, or metal with acute angles of 45° or angles of 30° and 60° with one or both sides bevelled so that ink will not run under triangle

H. Manual lettering device--an instrument consisting of a lettering template, scriber, and a tubular pen or a technical pen made for scriber use

I. Matte--lacking or deprived of gloss or lustre

J. Nib--pen point

K. Opaque--does not allow light to pass through

L. Pen point--device which consists of a shoulder of metal or plastic in a cylinder placed in a plastic color-coded point tube with an air channel and vent hole, a wire-weight, and a wire-weight safety cap

NOTE: Pen point width size may vary with the manufacturer; for example, Koh-I-Noor 6 x 10 to 14, Staedtler-Mars 5 x 0 to 6

M. Polyester drafting film--a tough translucent plastic drafting medium, usually made by bonding a matte surface to one or both sides of a clear polyester sheet

NOTE: Polyester drafting film is dimensionally stable and its size changes very little as humidity and temperature change; it withstands much erasing, is almost impossible to tear, and is moisture resistant

N. Technical pen--usually consists basically of a pen holder, ink cartridge, a point, and a cap

NOTE: This is sometimes referred to as a technical fountain pen

O. Transparent--has the property of transmitting or allowing light to pass through

P. Ultrasonic pen cleaner--device which uses millions of microscopic bubbles to clean the point of a technical pen

Q. Vellum--tracing paper which has been treated with a transparentizing agent which normally consists of waxes, oils, and similar substances

R. Watermark--a distinctive mark or design produced by the raised pattern of the dandy roll on the wet sheet; usually used as a trademark

II. Types of pen points

A. Stainless steel (for hand use and programmed automated digital plotters)

NOTE: Stainless steel pen points encased in plastic for hand use are available in larger sizes such as Staedtler Mars #6

B. Jewel (for hand use and programmed automated digital plotters)

NOTE: The jewel point can fracture if it is dropped, or if the point should meet with impact on a hard surface; therefore, do not tap a pen with a jewel point on the desk top

C. Tungsten-Carbide (for use with programmed automated digital plotters)

NOTE: Manufacturers of technical pens and pen points include the following: 1) Koh-I-Noor Rapidograph, Inc., 2) J.S. Staedtler, Inc., 3) Keuffel & Esser Co., 4) Faber Castell, 5) Reform Reforgraph, 6) Polygraph, and other brands which may be available in your location--check with your local technical pen dealer or manufacturer for technical assistance

III. Ways to properly use and care for technical pens

A. The proper way to hold the technical pen is vertically, with a very light touch

B. While drawing, always pull the technical pen; never push it

C. The air channel allows air to enter the ink cartridge in order to replace the ink that has been used

D. The technical pen should always be capped when not in use (even if not used for a short period of time)

E. The wire-weight should never be removed during cleaning, especially sizes .30mm #00 or smaller

F. When a technical pen is to be stored for an extended period of time, it should be cleaned well and filled with pen cleaning solution

NOTE: Check with the manufacturer for recommendation

G. Before using a pen that has been stored a long time, flush it with warm water, thoroughly dry it, and refill it with ink

IV. Characteristics of polyester film and procedures for using ink on polyester film

A. If the polyester film is matte on both sides, draw on either side; if it is matte on only one side, place the matte (dull) side up for drawing

B. Before putting any line work on polyester film, the film should be wiped clean with a moist paper towel

NOTE: For serious soils, use a liquid film cleaner

C. Ink can be easily removed from polyester film because the ink does not penetrate into the film

D. When desired, old ink lines can be removed easily from polyester film

E. Ink lines will flake or chip off the drafting film when some foreign materials are present between the ink line and the polyester film

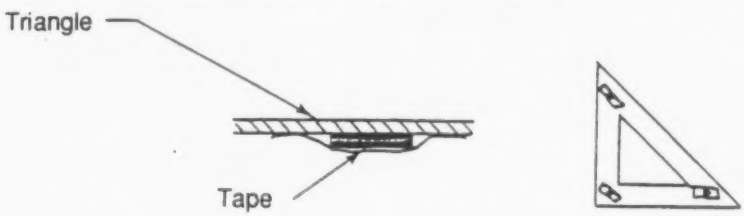
F. The matte coating (sometimes called tooth) is applied to polyester film so a line will adhere securely to the surface

G. For hand drafting, the most common thickness used is 3 mil

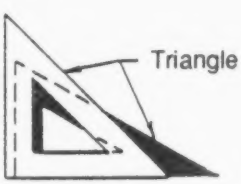
V. Useful tips for working with ink

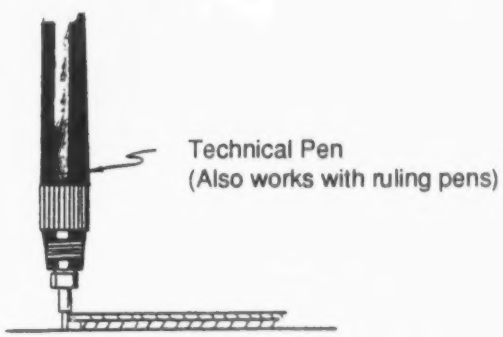
A. If an ink triangle is not available, use label-making tape or several layers of drafting tape on one side of the triangle to raise the triangle off the paper

NOTE: This can also be done with an irregular curve

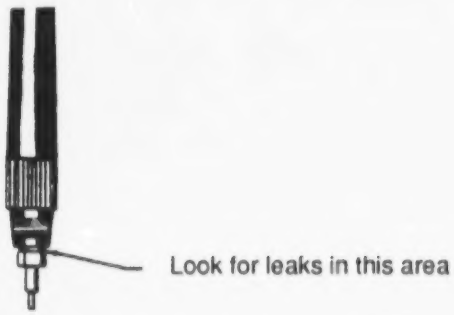


B. If an ink riser is not available, place another triangle under the one being used to prevent ink from flowing under the triangle

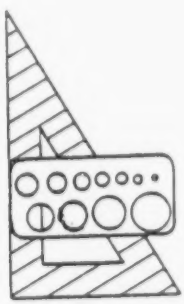




C. Periodically check the technical pen for leaking around the tip to prevent your hands from smearing the drawing; also check the tip for a drop of ink on the tip



D. If an ink riser is not available, place the template over a triangle to raise the template off the paper; the triangle gives good support and adequate clearance to prevent ink from running under template

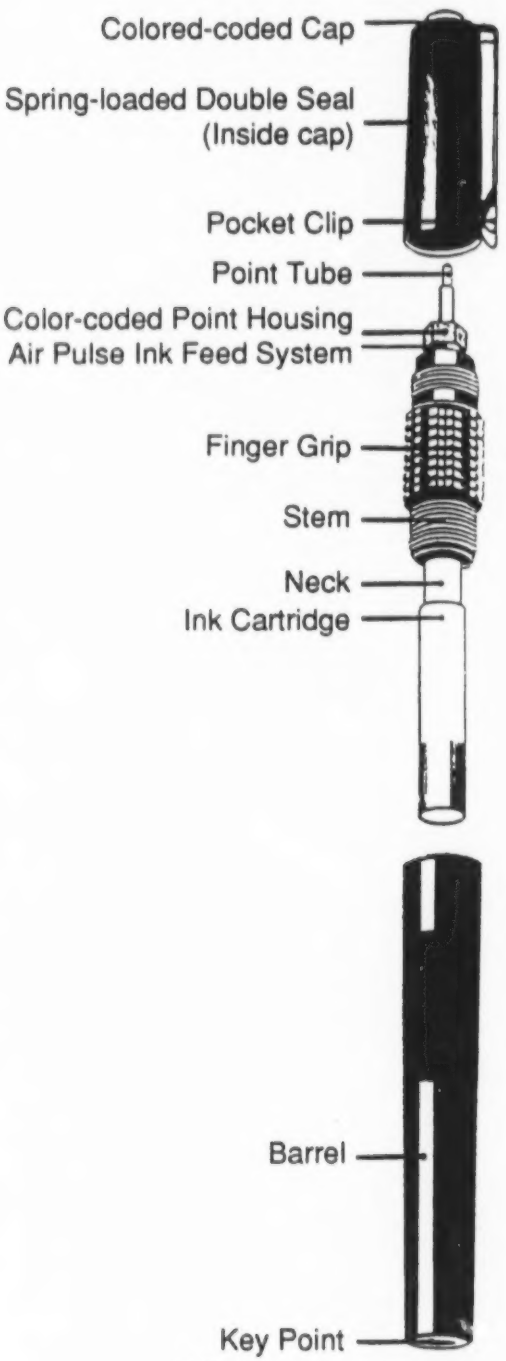


VI. Alphabet of ink lines

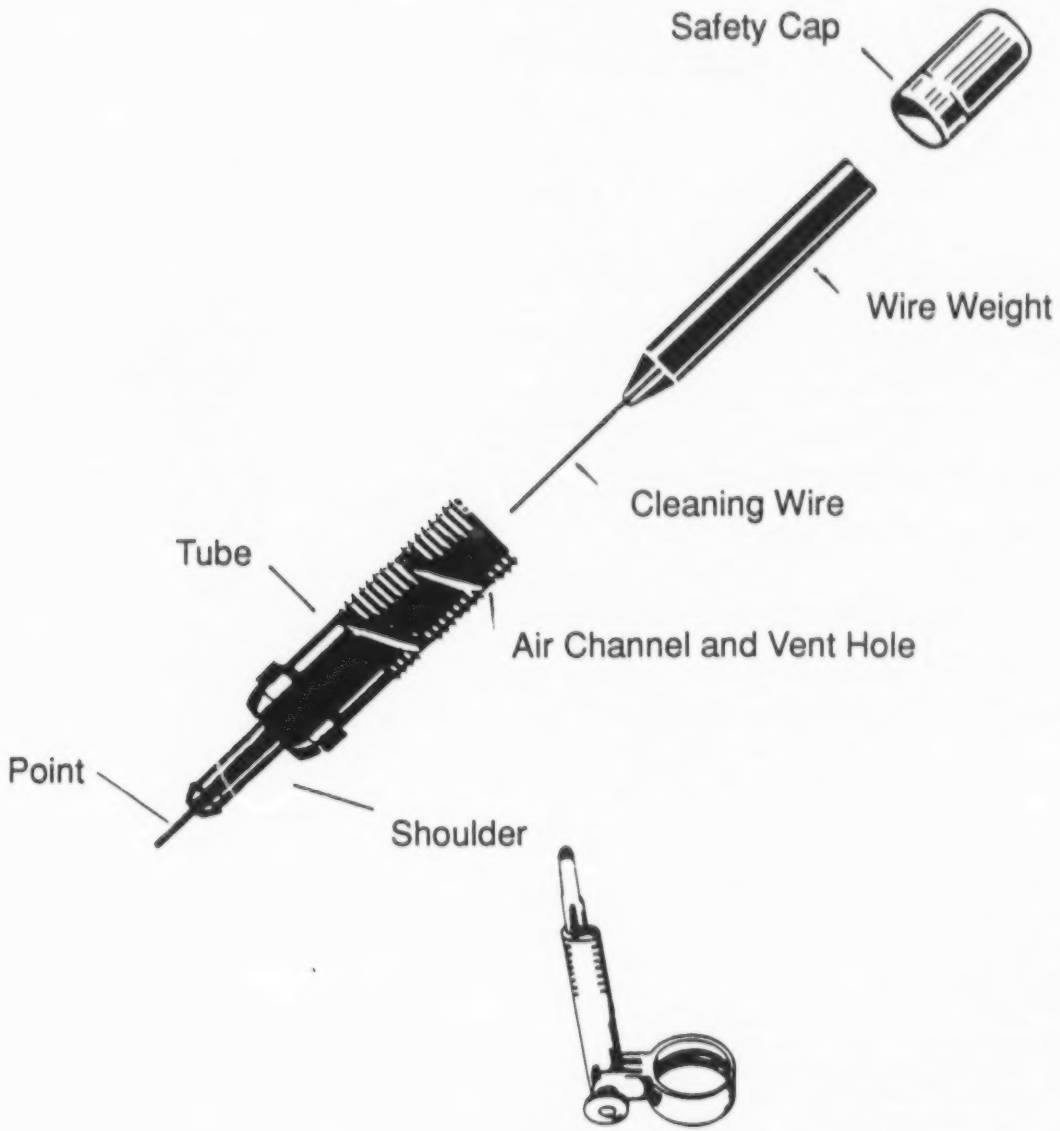
Name of line	Dimension	Approximate Width in in.	Recommended Pen size and number	Figure
Visible line	Thick	.030-.038	.50 mm 2	
Hidden line	Thin	.015-.022	.35 mm 0	
Center line (Symmetry line)	Thin	.015-.022	.35 mm 0	
Section line	Thin	.015-.022	.35 mm 0	
Dimension line	Thin	.015-.022	.35 mm 0	2.3
Extension line	Thin	.015-.022	.35 mm 0	2.3
Leader line	Thin	.015-.022	.35 mm 0	
Viewing plane or Cutting plane	Thick	.030-.038	.50 mm 2	
Short break line	Thick	.030-.038	.50 mm 2	
Long break line	Thin	.015-.022	.35 mm 0	
Phantom line or Adjacent part line	Thin	.015-.022	.35 mm 0	
Stitch line	Thin	.015-.022	.35 mm 0	
Chain line	Thick	.030-.038	.50 mm 2	
Border line	Thick	.038+	.80 mm 3	

NOTE: Symmetry lines are used in partial views or sections and are indicated by two short, thick parallel lines drawn at right angles to the center line

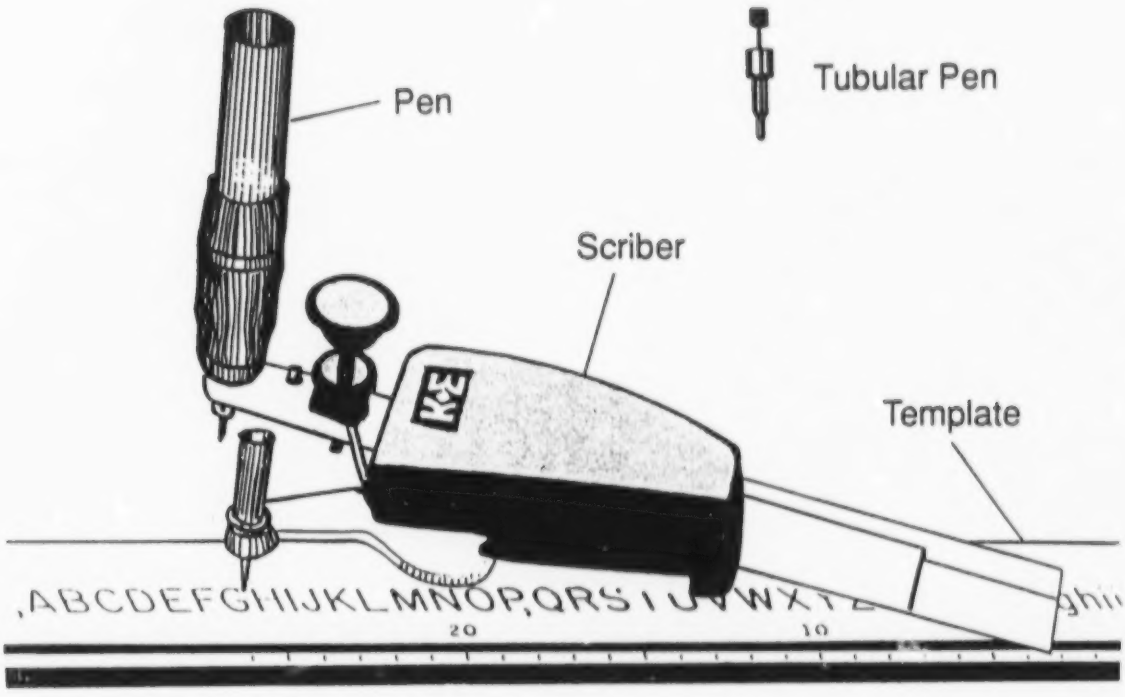
Technical Pen Parts



Pen Point


Safety Cap
Wire Weight
Cleaning Wire
Tube
Air Channel and Vent Hole
Point
Shoulder
Attachment for Compass

Manual Lettering Device



DRAW AND ERASE INK LINES ON VELLUM OR TRACING CLOTH

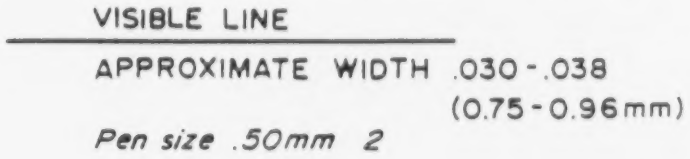
Premise: Ink lines can be drawn and erased on vellum or tracing cloth by using the procedures in the following examples.

Example A: Drawing on vellum or tracing cloth

1. Use ink and media size determined by instructor.
2. Decide which side of media to use.

   NOTE: Place felt side of vellum up or dull side of tracing cloth up.
3. Tape media down on drawing table.
4. Clean media if necessary.
5. Draw the needed line.

   NOTE: A visible line is used in this example.



6. Letter the name of the line above the line in vertical upper case lettering using a manual lettering device.
7. Letter in below the line the words "Approximate width" and the approximate width figures in English and metric.
8. Letter in the recommended pen size in slant lower case lettering.

Example B: Erasing on vellum or tracing cloth

1. Check type of eraser to make sure that it is one of the recommended types for use on vellum or tracing cloth.
   a. Recommended types for manual use
      1) Plastic embedded with erasing fluid

         NOTE: These should be stored in air-tight containers.
      2) Soft, white plastic
      3) Soft, white vinyl

4) Soft, pink rubber

NOTE: Use of this type will be time consuming.

5) Soft, green

NOTE: This type effectively removes dirt withou newly dried ink lines if properly used.

b. Recommended types for cord or cordless electric erasing

1) Soft, white plastic

2) Soft, white vinyl

3) Soft, pink rubber

4) Soft, green

(**CAUTION**: A grey, abrasive eraser strip should of the eraser coupled with heavy hand pressur surface.)

NOTE: Because some vellums and tracing c experiment to determine the best eraser for the j

2. Erase carefully with an electric eraser or an eraser for manual use

VISIBLE LINE

APPROXIMATE WIDTH .030 - .03
(0.75 - 0.9

Pen size .50mm 2

NOTE: In this example only half of the original line drawn in Exa

3. Reproduce on blueline print machine to check "ghosting".

DIRECTIONS: Draw and label appropriately the complete alphabet of i drawn lines and reproduce on blueline to check "ghosting." Refer to ob for a listing of the alphabet.

ne consuming.

ves dirt without smudging and will not weaken sed.

electric erasing machines

ser strip should not be used because the speed y hand pressure will tear a hole in the media

and tracing cloths are porous, it is wise to eraser for the job.

r for manual use

H .030 - .038
(0.75 - 0.96 mm)

ne drawn in Example A is erased.

nosting".

te alphabet of ink lines. Erase one-half of the ng." Refer to objective VI of information sheet

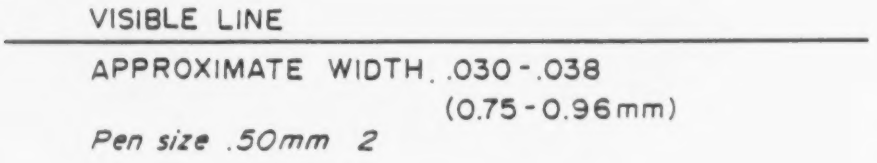
DRAW AND ERASE INK LINES ON POLYESTER FILM

Premise: Ink lines can be drawn and erased on polyester film by using the procedure in the following examples.

Example A: Drawing on polyester film

1. Use ink and polyester film size determined by instructor.
2. Place matte side of polyester film up.
3. Tape film down on drawing table.
4. Clean film if necessary.
5. Draw the needed line.

   NOTE: A visible line is used in this example.



6. Letter the name of the line above the line in vertical upper case lettering using a manual lettering device.
7. Letter in below the line the words "Approximate width" and the approximate width figures in English and metric.
8. Letter in the recommended pen size in slant lower case lettering.

Example B: Erasing on polyester film

1. Check type of eraser to make sure that it is one of the recommended types for use on polyester film.

   a. Recommended types for manual use

      1) Plastic embedded with erasing fluid

         NOTE: These should be stored in air-tight containers to prevent evaporation.

      2) Soft, white vinyl

         NOTE: For best results, moisten the tip.

      3) Soft, white plastic

      4) Soft, pink rubber

5) Soft, green

b. Recommended type for cord or cordless electric erasers-soft, white vinyl

NOTE: A great deal of caution should be used with electric erasers because the speed of the eraser and heavy hand pressure produce friction and heat which may damage the matte surface. Some manufacturers of polyester film do not recommend the use of an electric eraser.

(**CAUTION:** A grey, abrasive eraser strip should never be used because it will totally damage the matte surface.)

2. Erase carefully with a recommended type of eraser or use erasing fluid

a. First, a small amount of erasing fluid is placed on a sponge

b. Next, a special eraser is dabbed onto the sponge

c. Then, the eraser is used on the film in the standard fashion

NOTE: For large areas extra strength erasing fluid can be applied to a soft paper towel.

VISIBLE LINE

APPROXIMATE WIDTH .030 - .038
(0.75 - 0.96 mm)

Pen size .50mm 2

NOTE: In this example only half of the original line drawn in Example A is erased.

3. Reproduce on blueline print machine to check "ghosting"

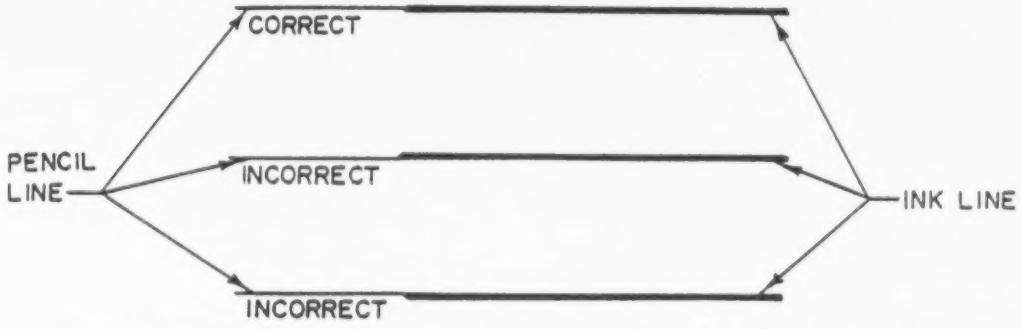
Directions: Draw and label appropriately the complete alphabet of ink lines. Erase one-half of the drawn lines and reproduce on blueline to check "ghosting." Refer to objective VI of information sheet for a listing of the alphabet.

COMPLETE STEPS IN INKING A DRAWING OR A TRACING

Premise: A drawing or tracing can be inked by using the procedure in the following example.

Example:

1. Ink all arcs and circles first, by centering the ink lines over the pencil lines.



2. Ink all straight lines, next, doing the horizontal, then the vertical, and last the inclined lines.

   NOTE: It is far easier to join straight lines to arcs than to join arcs to straight lines.

3. Ink all extension, dimension, and center lines.

   NOTE: Some drafters prefer to ink center lines before making compass center. This helps to keep ink from running through the holes in the media surface.

4. Ink in all arrowheads and lettering.

   NOTE: Draw guidelines for lettering directly on the media surface.

5. Be PATIENT; allow ink to dry before inking adjacent lines.

6. If an error is made, wait until it dries; then use an erasing shield to protect the line work near the error.

Directions: On media and size determined by the instructor, ink all parts of the drawing.

DRAW LINES ON A DRAWING MEDIUM USING INK

Directions: Make two drawings

1. Make one drawing on a sheet of vellum with ink. (Ink and media size to be determined by the instructor.)
2. Make one drawing on a sheet of polyester film. (Ink and size to be determined by the instructor.)
3. Include the complete alphabet of lines.
4. Show variations in line width.
5. Reproduce on the print machine.

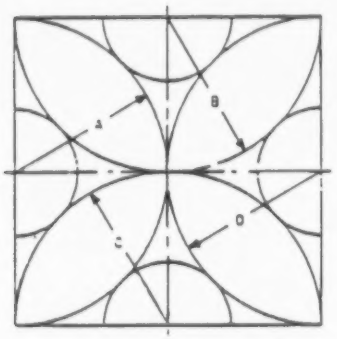


FIG. 1

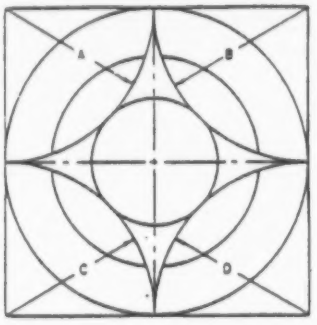


FIG. 2

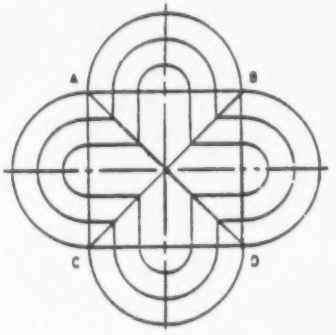


FIG. 3

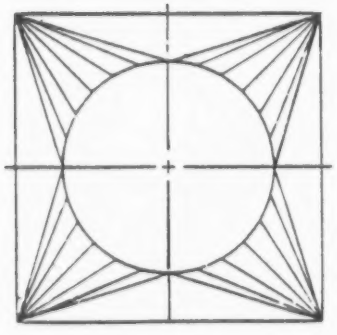


FIG. 4

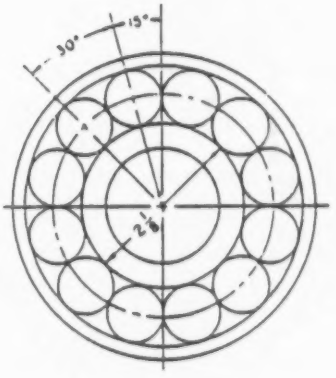


FIG. 5

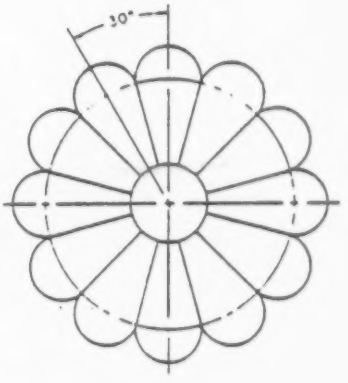


FIG. 6

MODULE: DRAFTING FUNDAMENTALS

UNIT X: INKING TOOLS AND TECHNIQUES

UNIT TEST

Match the terms on the right with their correct definitions on the left.

___	1.	Does not allow light to pass through	a.	Ink
___	2.	Has the property of transmitting or allowing light to pass through	b.	Pen point
___	3.	Tracing paper which has been treated with a transparentizing agent which normally consists of waxes, oils, and similar substances	c.	Vellum
___	4.	A tough translucent plastic drafting medium, usually made by bonding a matte surface to one or both sides of a clear polyester sheet	d.	Technical pen
___	5.	Lacking or deprived of gloss or lustre	e.	Nib
___	6.	A liquid composed mainly of carbon in colloidal suspension and gum	ab.	Opaque
___	7.	Usually consists basically of a pen holder, ink cartridge, a point, and a cap	ac.	Transparent
___	8.	Pen point	ad.	Polyester drafting film
___	9.	Device which consists of a shoulder of metal or plastic in a cylinder placed in a plastic color-coded point tube with an air channel and vent hole, a wire-weight, and a wire-weight safety cap	ae.	Matte
___	10.	Firm or steady attachment	bc.	Adhesion

Match the terms on the right with their correct definitions on the left.

___	11.	Capable of forming an homogenous mixture that does not separate or alter by chemical interaction with each individual substance or material	a. Manual lettering device b. Ultrasonic pen cleaner c. Ghosting d. Compass adapter e. Watermark ab. Ink triangle ac. Compatible ad. Ink riser ae. Feathering
___	12.	Occurs when an ink line spreads in an uneven fashion; usually due to drawing on the wire side of the vellum	
___	13.	A distinctive mark or design produced by the raised pattern of the dandy roll on the wet sheet; usually used as a trademark	
___	14.	Device which uses millions of microscopic bubbles to clean the point of a technical pen	
___	15.	A straight-edged three sided device whose total angles equal 180° made of thin, flat plastic, or metal with acute angles of 45° or angles of 30° and 60° with one or both sides bevelled so that ink will not run under triangle	
___	16.	Thin plastic template placed under a template or triangle so that ink will not run under template or triangle	
___	17.	A device for technical pens to hold the pen in the proper position in a compass	
___	18.	An instrument consisting of a lettering template, scriber, and a tubular pen or a technical pen made for scriber use	
___	19.	A smudged area or image on a reproduction copy of a drawing caused by a damaged surface due to erasing or mishandling of the original	

Mark a "T" for true statements and an "F" for false statements concerning the ways to properly use and care for technical pens.

___ 20. The proper way to hold the technical pen is horizontally, with a very heavy touch

___ 21. While drawing, always push the technical pen; never pull it

___ 22. The air channel allows air to enter the ink cartridge in order to replace the ink that has been used

___ 23. The technical pen may be left uncapped when not in use for short periods of time

___ 24. The wire-weight should always be removed during cleaning

___ 25. When a technical pen is to be stored for an extended period of time, it should be cleaned well and filled with pen cleaning solution

___ 26. Before using a pen that has been stored a long time, flush it with warm water, thoroughly dry it, and refill it with ink

Identify true and false statements concerning characteristics of polyester film and procedures for using ink on polyester film by marking a "T" for true statements and an "F" for false statements.

___ 27. If the polyester film is matte on only side, place the shiny side up for drawing

___ 28. Before putting any linework on polyester film, the film should be wiped clean with a moist paper towel

___ 29. Ink is difficult to remove from polyester film

___ 30. Ink lines will flake or chip off the drafting film when some foreign materials are present between the ink line and the polyester film

___ 31. The matte coating is applied to polyester film so a line will adhere securely to the surface

___ 32. For hand drafting, the most common thickness used is 15 mil

33. **List three types of pen points.**

a. _____

b. _____

c. _____

34. **Discuss useful tips for working with ink.**

_____

_____

_____

ANSWERS TO UNIT X TEST

1. ab (B1)
2. ac (B1)
3. c (B1)
4. ad (B1)
5. ae (B1)
6. a (B1)
7. d (B1)
8. e (B1)
9. b (B1)
10. bc (B1)
11. ac (B1)
12. ae (B1)
13. e (B1)
14. b (B1)
15. ab (B1)
16. ad (B1)
17. d (B1)
18. a (B1)
19. c (B1)
20. T (B2)
21. F (B2)
22. T (B2)
23. F (B2)
24. F (B2)
25. T (B2)
26. T (B2)
27. F (B1)
28. T (B1)
29. F (B1)
30. T (B1)
31. T (B1)
32. F (B1)

33. The following in any order: (B1)

    a. Stainless steel
    b. Jewel
    c. Tungsten-Carbide

34. Discussion should include: (B2)

    a. If an ink triangle is not available, use pennies or drafting tape on one side of the triangle to raise the triangle off the paper
    b. If an ink riser is not available, place another triangle under the one being used to prevent ink from flowing under the triangle
    c. Periodically check the technical pen for leaking around the tip to prevent your hands from smearing the drawing; also check the tip for a drop of ink on the tip
    d. If an ink riser is not available, place the template over a triangle to raise the template off the paper; the triangle gives good support and adequate clearance to prevent ink from running under template